Paolo Legrenzi

Creativity and Innovation
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And God said, ‘Let there be cake.’
And there was cake.
And God saw that it was good.

K. Mansfield, *Psychology in Bliss and Other Stories*, 1920

In the novel *Man without Qualities*, Robert Musil dreads the day in which a racing horse is considered gifted. We already call the best athletes talented, magical or legendary. This type of misuse of terms is now also occurring with *creativity*. It is an ingredient used for numerous dishes, a sort of passe-partout that we resort to when we have used up all other common interpretations. Such factors as *Made in Italy*, the future of a country, the rising costs of labor and export hint at, more or less explicitly, the intervention of this *deus ex machina*, or problem solver, as well as innovation, inimitable differences, and competitive advantage. Ancient professions like that of architecture have been contaminated by this term, as the famous architect Vittorio Gregotti observes:

> Every work of architecture seems to be justified by the term *creativity*, which by now is used to define every aesthetic act (diffused aesthetics has overwhelmed us) with which designers, advertisers, stylists, architects and many other professions justify their “artistry”. (Trans. Knaeble)

What exactly is creativity? Is it just a word? A common notion? An umbrella that covers the most varied of things such as entrepreneurial skills, inventiveness, good taste, industrial competitiveness, or traditional craftsmanship? Creativity is considered the lowest common denominator of *Made in Italy*’s roots. How many of the great entrepreneurs of the second half of the last century could we say possessed the same qualities as those described in the following statement on Giannino Bassetti, published in the Italian newspaper “Sole 24 Ore”, edition “Domenicale” of Dec. 19, 2004?

> “[…] strong entrepreneurial ability with a noticeable appeal for intuitive and pragmatic innovation […]”. (Trans. Knaeble)

Without innovation and creativity the world of today, and of yesterday, would appear quite different. What is the mechanism, if there is one, that allows people and organizations to go on inventing and creating fabrics, shoes, clothes, eyeglasses, bags, furnishings, cars, and other objects for the home, work place, and leisure activities? Does their inventiveness have no limits? Does it concern true renewal or merely replication, infinite variations on a single theme?

The challenge lies in dealing with the combination of creativity, as an ability of single individuals, and innovation, as a collective phenomenon. Today these two factors are often confused.

Creativity and innovation were traditionally two adjacent, yet separate, research fields. The first was mostly dealt with by psychologists, the second mainly by economists. Research
conducted over the last decade has broken all boundaries of a field that was once also the prerogative of science historians, art critics, company consultants and marketing experts. In studying these matters, I have essentially tried to respond to the following question: “Why are we not able to be a bit more creative more often?”. Today we are capable of dealing with this question if placed in a common theoretical framework, one which I will present at the end of this book. I will also give some indications as to what I call the pedagogy of creativity, namely the desire to learn to be creative.

In the first part of the book I have included exercises which help personalize the various arguments. The second part is dedicated to technological innovation and collective phenomenon.

The final section of the book is where I list sources and references for anyone wishing to find out more on the topics treated herein. Dissatisfied readers are welcome to write to me at legrenzi@iuav.it.

I would like to pay particular homage to my teacher and instructor, Philip Johnson-Laird, who inspired this work, but who is not responsible for any possible mistakes. In addition I would like to thank my new work environments and colleagues: the University Iuav of Venice, especially Emanuele Arielli, Roberto Casati, Medardo Chiapponi, Vittorio Girotto, Pier Luigi Sacco and Angela Vettese for their precious advice and time; the PhD School which is promoted by the two Venice Universities of Ca’ Foscari and the Iuav; the Venice International University for its research center; the Venice Foundation, sponsor of this research and educational initiative; and all the people who collaborated on this project, including various friends (in particular Gianni Toniolo for information on trademarks and patents). The kind support from Eni and Unicredit allowed me to test many of the examples illustrated in this book. Finally, a special thanks to my two editors, Giovanna Movia and Alessia Graziano, from Il Mulino, for their time and patience in correcting the manuscript (and also other past books).
1. The long history of creativity

Products and processes

The words *creativity* and *innovation* can be heard used in the media and in everyday conversation to refer to both a *product* of human creativity and to the *processes* involved in the development of a product. The two quotations cited in this book’s preface are examples of this duality. We will mainly concentrate on the latter of these meanings, whereas other studies focus on the evaluation of products once they have been produced.

The charm of a product, for example that of a building or a drawing, does not only come from its features but also from the indications they convey about the processes of invention. James Ackerman, Emeritus Professor at the University of Harvard, in an attempt to explain his impetus for more than sixty years of dedication to the history of architecture, wrote:

For example, what interests me most in works of art has nothing to do with their “aesthetic” features (“aesthetic” is a concept that functions in a vicious circle, where basically something is considered beautiful because it has its own beauty), nor with the quality of the work, a term which was once used to distinguish aristocracy from common folk. What interests me is witnessing an exceptional outcome of the imagination or invention.1

Literary, artistic and musical critics have their own criteria for evaluating a work of human intellect. Scientists know how to distinguish a creative solution to a scientific problem from a less creative one (or one which lacks creativity entirely). Designers and architects speak of creative works, or works that are academic or traditional in nature. Technologists occasionally make recourse to creativity in order to evaluate manufactured industrial products. Which of the solutions for the bridge over the straight of Messina is more creative? Even mathematicians speak of creative evidence or unrefined solutions. All of these experts draw upon their own knowledge when trying to decide whether a human-made product is more, or less, creative, innovative, or well-made with respect to another, or whether the products are designed for similar purposes or not. So much so that it is said that the originality of a work can be evaluated independently from the person who created it. The works of Homer and Shakespeare are historical examples of this. The question is a long-standing one and opinions vary.

In the summer of 2004 a series of letters was discovered which had been written by the Italian author, Italo Calvino, in the 1950s, and addressed to a woman with whom he was presumably in love. Some experts refuse to believe that this revelation of the author’s frame of mind can explain the motivations for his book, *The Non-Existent Knight (Il cavaliere*

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1 Trans. Knaeble; taken from J.S. Ackerman, *La Storia come autobiografia, Reminescenze Storiche*, in F. Cigni and V. Tomasi (ed.), *Tante Storie*, Milan, Bruno Mondadori, 2004
insistente), written in those same years. Whether the main character was actually modeled on the husband of Calvino’s lover or not has little importance today. The knight is sheer intellect, an uncontaminated machine that applies rules, lacks emotions, and is made of crystalline perfection. Nevertheless, the character is conscious of himself and is not a robot. Once he has been created by his maker, he breaks free of him; thus he lives unalterable and forever. He enjoys an independent life as do the other great characters in the history of literature, theatre and opera. He is reborn each time a reader becomes immersed in the imaginary tale. Calvino, the writer, creates (or recreates?) a previously experienced pleasure with every new reading.

Here lies the first difference between artistic and scientific creativity. Scientific discovery does not acknowledge replications, only confirmations. Whereas artistic creativity inspires replication. Ludwig Wittgenstein, the early twentieth century Austrian philosopher, asked himself what type of cognitive experience do we undergo when we behold something beautiful. His answer was simple: we want to draw it. A young boy named Leonardo suddenly sees a beautiful face drawn by Verrocchio. He proceeds to copy it repeatedly. The same happens when he sees a lovely plant. He makes a first, then a second, then a third copy. In short, and paraphrasing the contemporary American philosopher, Elaine Scarry, we can say that beauty inspires replication. In the case of science, replication is sheer confirmation. What unites the two fields is the need for a creator. It seems obvious that in order for creativity to produce a product, there must exist a creator – even if only imaginary or metaphorical. Some believe there exists only one single Creator of the entire universe – a Creator par excellence. If this were the case, then Creation must have happened “en masse”.

When I was young the work of my father, an engineer, fascinated me. I was disappointed when I finally realized that he was involved in designing the concept or ensemble of these projects, and was not involved in their specific construction. In my eyes, the true artisans of those marvelous creations were the workers. In human creation there exist hierarchies and gradation. There are two types of conditions that pertain to humans:

- every scientific or technological solution, any discovery or innovative product, is creative in respect to another which is less creative;
- a work of art that produces pleasure, joy, amusement (or any other emotion), re-creates that emotion each time one comes in contact with it.

A work of art re-creates the same pleasurable effect as long as we, ourselves, do not change in the meantime. As Nobel Prize winner in economy, Gary Becker, observed that people who attend concerts invest time in refining their musical aesthetic sense, and therefore give themselves the chance of improving their tastes. An economist might say that in this way human capital is increased. Thus, taste can be cultivated and perfected in the same way that our game of tennis, or skiing abilities can improve if we dedicate time and resources to them.

**Exercise:** Try re-reading a book which you have enjoyed, or watching a film a second time. Do you enjoy it or are you moved merely because you realize you have forgotten it? Or does your enjoyment come from rediscovering the passages or scenes which initially pleased you?

Just like other abstract concepts, as for example *happiness*, we can compare the uses of an adjective like “creative” with that which is not creative. It is easy to see that the meaning of *unhappy* is not the opposite of *happy*. But what is the opposite of creative? A-creative? Let’s try to turn the term upside down, or look at its reverse meaning, and we will find a myriad of exceptions.
How many things can be things which are not creative? A thing can be academic or educational (art), repetitive (art), imitative (art), cloned (industry), cloned (industry), derivative (a not very original replication in the field of science), obliged (strategy), old (style), serial (production), traditional (taste), out-dated (fashion), predictable (advertisement), useless (gesture), common (solution), boring (story), futile (approach), weak (intervention), and so on.

In addition to the term’s semantic overturning, let’s look at another litmus-like linguistic test: the “but” test. Something is creative but.... Which adjectives could you place after the word “but”? Do the adjectives mentioned above work? Perhaps a few, but only just. We need to find an adjective which does not cancel the meaning of the first half of the phrase, but merely modifies it, partially. Try it yourself.

Let’s go back to The Creation story. We said that the Creator cannot be creative, but humans can. Why is that? The answer is simple. If we want to continue making comparisons and assessments by using creativity as our measuring gauge, then this process must be understood as a phenomenon limited to a specific area, and not as a supernatural and global event. Even a hypothesis on the (natural) genesis of the universe can be said to be more or less creative than another, in that it is more surprising or more imaginative, more ingenious in its invention or discovery. For example, some people believe that the conditions which induced the appearance of life forms on earth were present on the planet since its origin, at the time of the Big Bang. Others believe that these conditions had been created over the course of evolution. And still others hypothesize that the building blocks of life were synthesized in interstellar space and were then brought to earth via meteorites or comets. Is this last notion the more creative one? Perhaps it is. Indeed Gianfranco Vidali, a physicist from Trieste and scholar at Syracuse University in New York, was creative when he constructed a machine for simulating the furthermost conditions of interstellar space. A star, at the end of its life, forms interstellar dust particles with diameters of nearly one thousandth of a millimeter. Recently an amino acid composed of this dust has been found in interstellar space. Life on our planet is based on amino acids. When they are bound together in a particular sequence, they form proteins. And proteins are what make up DNA. Who was more creative then? Certainly Vidali was. He invented and built a machine that simulated this cosmic process. The actual process that took place in space was the result of a deterministic sequence. What is produced in nature, given certain base conditions, cannot be produced in other ways. Zero creativity. There is no creativity without freedom. Freedom to create in another way. Simulation is therefore “creative” because, beginning with everyday conditions, it forces us to proceed backwards in time. It is a sort of deconstruction aimed at identifying a past from amongst the many theoretically possible. In psychology parlance, we say that it is necessary to define the space of a problem that has many degrees of freedom. As will be explained in the next chapter, this is the typical form of creativity required for solving problems.

In 1902 Benedetto Croce wrote to one of his contemporaries, the philosopher of science Vailati;:

Dear friend,

Thank you for your review of the speech by Volterra. There is no doubt that the application of mathematics is valuable for resolving or simplifying the intricate questions of practical nature […]. Mathematics will number and measure objects, but economics is based on choice and will, etc., namely, it is nothing that can be ascribed to the considerations of mathematics.²

Croce relied on an intuitive distinction which is part of common sense. Mathematics is a language nurtured by postulates, axioms, rules and procedures. Whereas human behaviour is made up of deliberate and intentional choices, even in the field of economics. In order to be creative, one must be free to choose. And this process of choice cannot be described in analytical terms or by mathematic models. It is this last point in Croce’s reasoning which is unfounded. Unfortunately, Croce’s point of view is still widely upheld even today. This book attempts to demonstrate, as we shall soon see, that such an opinion is incorrect even if Croce’s remark has come to be accepted as common knowledge, and that there is also a speck of good sense in it.

Creativity, art and science

Nearly twenty thousand years ago our ancestors made drawings of bison on cave walls. There were more ways than one in which they could have done this. Their ability to use the natural shapes of rocks in their creation of animal profiles undoubtedly constituted the first form of land art, namely art found on a natural site. In 1994, on the occasion of the Alvar Aalto conference in Jyväskylä Finland, artist Mary Miss (b. New York, 1944) built a series of basins along an area of nearly eight square kilometers. The basins were anchored at the base of tall pine trees in such a way as to collect rain water and to emphasize the linearity of the trees with which they were intertwined. Twenty thousand years later the work of Mary Miss can be seen as not so very different from that of our cave dwelling ancestors. In the meantime, over the course of this long period, human civilization has developed many standards of judgment and frames of reference aimed at attributing the label of “creativity” to a product of human ingenuity, or in other words to an artifact. The standards of judgment and reference frames for creativity have changed over the centuries. Only one has remained invariant: in order for something (an object, an action, or an event) to be defined as creative, it must be the product of a free act and not of a deterministic process. Here we see another type of condition in addition to those mentioned in the previous paragraph. In synthesis: the non-determinism of the process allows for freedom of choice.

In the collection at the Guggenheim Museum in Bilbao there is a short 35-mm film which shows Pablo Picasso drawing a figure on a spotless wall. One sees that each of his gestures is freely made. The first few strokes condition those which follow, but do not constrain them. Little by little, stroke after stroke, the painter’s overall intention becomes evident. At the same time the film gives the impression that Picasso chooses how to proceed step by step. Picasso was filmed by Luciano Emmer, Italian inventor of art films, in June of 1955 in the gothic chapel of Vallauris in the south of France. Emmer remembers how only two days after having shot the film, he returned to the chapel to find the drawings gone and the wall spotless. The workers who had been employed to prepare the wall for the fresco, mistook the drawings as graffiti or form of vandalism and erased them purposely. The only remaining proof of Picasso’s work consisted in the film footage, which was later restored for the Bilbao exhibition. The film is the recording of a process of individual artistic creation. From freedom to choice. If a work is a masterpiece, it gives us the illusion that it would have been impossible to have created it in any other way. Whereas with a work is of modest caliber, the errors in design or execution are clearly more evident. Overall, the creativity found in artifacts tells us about a history of human civilization that dates as far back as those first cave drawings. The systematic analysis of creative processes is, on the other hand, only a century old.
Exercise: Try asking yourself how many of your actions are done freely and how many are determined by someone, or by something else. When trying to reach a certain goal, are you able to feel creative if you use methods established by someone else? What is the fine line between freedom and choice?

When modern science, which is made up of experiments and measurements, was first born, it tried to expel the human factor. The goal was to obtain objective data as a means to support and test theories. Modern science investigates nature by means of experimentation. Man, the observer, should not influence the results of the investigation. The history of modern science is also the history of the attempts at eliminating or controlling man as observer. For many centuries scientists were forced to personally interact with the machines that were used in collecting information from the outside world. They involved instruments, such as the telescope and microscope, which were invented for observing what the naked eye could not. For this reason eye-glasses for short-sightedness, the first prosthesis interposed between observer and the observed world, were invented nearly two centuries prior to those for far-sightedness. People who worked in agriculture or trades did not necessarily need to have good eye-sight, but those who worked and dealt with documents and texts did.

In the second half of the 19th century European astronomers detected the transit of heavenly bodies with the use of a complicated apparatus comprised of a telescope and metronome. A grid was placed over the eyepiece of the telescope and when a heavenly body appeared, they would try to match a point on the grid with a beat of the metronome. In this way astronomers established that the object under observation was in a well-determined and fixed position at a certain precise moment. These results were then exchanged among the various astronomy centers across Europe.

Lord Nevil Maskelyne, astronomer royal in London, noticed that the recordings of transits sent to him by one of his assistants revealed a constant deviation with respect to those observed at a German observatory. Assuming the deviations were due to a lack of attention on part of his assistant, Maskelyne dismissed him. The episode induced other directors from various centers to re-examine and confront their findings. What emerged was that every observer seemed to be characterized by what is called his “personal equation”. Our perceptive system does not directly reveal reality, but filters it through the observer (taking into account the observer’s reaction time and skills in doing a particular job). Astronomy experts had learned to improve their methods for observing the sky although a margin of difference still remained. This margin could be corrected by a personal equation.

This episode, devastating for an employee but marginal in the larger context, marked the entrance of the issue of subjectivity into the temple of objectivity. A new era began: unable to eliminate the “subject observer”, the scientist or researcher was transformed into the “observed object”. In other words, human behaviour began to be studied with the same empirical methods that had been used for examining nature since Galileo’s time. Thus, the science of psychology was born.

Scholars began examining not only their own scientific objectives, but also the methods they used in reaching them. It became common practice to keep a diary of one’s work and progress, and particularly of the methods one used for testing hypotheses. Almost two centuries later, these forms of diaries have become valuable sources for understanding the dawning of scientific creativity. For example, the psychologist and historian of American science, Ryan Tweney, analyzed in detail the notes of Michael Faraday, the famous English physicist (1791 to 1867) who had studied the relationship between electricity and magnetism. Given that Faraday had taken an infinite array of notes on almost everything, it was relatively easy for Tweney to notice the occasions in which “creative leaps” had been made in the
physicist’s work, or to trace his method of making discoveries, or to understand how he had formulated and examined his hypotheses. Tweney also challenged the reductionism of sociologists like Bruno Latour and Steve Woolgar. In their classic essay published in 1979, the title of which is a program, *Laboratory Life: the Construction of Scientific Facts*, the two scholars maintained that scientific creativity was the product of cultural and social forces. These forces influenced “external history”, the history of complex conditions that make science possible in a given society. External history should be distinguished from “internal history”, that is from the succession of ideas, hypotheses, theories and experiments in a given scientific field. The internal history of a scientific field is part of the flow of ideas of a given era and culture. Tweney pursued a third path, which we will also attempt to follow here. Besides the importance that internal and external factors may have in scientific progress, he wondered what the mechanisms might be which generate creativity. In this case his work has been aimed at analyzing, in depth, the methods Faraday used to construct his discoveries.

In a conference held at the Sorbonne in 1912, the famous mathematician Vito Volterra, explained the evolution concerning the basic ideas of infinitesimal calculus:

> We see, therefore, that after a period of seventeen centuries, during which the fertile ideas of infinitesimal calculus were hidden and dulled, they suddenly awoke and began to flourish with an unexpected burst of development. Within the course of nearly two centuries they had remarkably surpassed their original limits and, more importantly, left Geometry behind, so as to create, by their penetration into Natural Philosophy, what we know as modern Science.³

How did this reawakening happen? Sociologist Bruno Latour would say that for one thing it was due to the industrial revolution. A historian of ideas might say it was due to the fact that mathematics helped to serve the purposes of physicists like Galileo and Kepler, perfectionists of the analytical instrument. Actually, the simplest question of dynamics, namely that of the fall of bodies, was solved by Galileo through a method of breaking down the fall time into small intervals and by considering the movement in each interval as uniform. Today a psychologist interested in creativity might say that there is yet another reason. Before Galileo decided to rely on experiments, and in so doing managed to trace results back to abstract entities – namely to the subject matter of physics to which mathematical analysis can be applied, most people relied on what they saw with their own two eyes as proof. And our eyes tell us another story, as the Italian experimental psychologist Paolo Bozzi would demonstrate some centuries later. We do not actually witness bodies falling and sliding along inclined planes, as the principles of classical physics describe. This is because a body moves with a “natural” start, and its motion, initially, must be gently accelerated. The movement of a body that is objectively uniform is usually seen to start with a sudden initial leap or jolt. What does all of this teach us about creativity? It tells us something of two great advances in history. The first was made by Galileo when he disregarded the subjective appearance of phenomena and began constructing an objective science. The second occurred in the 19th century when the disparity between objectivity and subjectivity was questioned. Thus a metric of subjectivity was constructed. The mechanisms of subjectivity and objectivity, two aspects of the same problem, were unveiled thanks to these two creative and interrelated leaps: had it not been for the first, the conditions for the second would not have been made possible.

Since the 19th century it has been established by scientists that nature does not function at random but according to precise deterministic laws. However, these deterministic laws - perfection of the intellect - were discovered thanks to processes which were neither very clear nor linear. And this did not apply to science alone, but to its numerous technological applications as well. The industrial society emerging at the time depended upon the work of thousands of inventors and discoverers of new gadgets and patents. Thus, the question of education in creativity was posed. Was there a conceivable kind of pedagogy for creativity? Developing an educational program requires a precise and articulated idea about the nature of the subject matter which one wishes to teach. Did the question make sense? Why were some scientists and technologists more creative than others? Ever since then we have been never been free ourselves of these questions. The answers proposed by historians of science and by sociologists fell short of giving a sufficient explanation of the issue of creativity, and hopes for an answer were placed on cognitive scientists. Unfortunately, it was still long time before the answers were to come.

In the case of artistic creativity, it might be tempting to rid oneself of the problem by reducing it to ascertaining that some artists are more talented than others. But what is talent? The manifestation of an innate or learned ability? An inherited instinct? If artistic creations are prototypes, unique pieces that cannot be repeated, discovering how they came to be may not be all that important. Many scholars actually believe that it is misleading to know. Massimo Mila, music critic and essayist, thoroughly analyzed this problem with connection to the artistic expression of music. Music can be described in almost formal terms, aside from, that is, its contents. Computers can be programmed to produce works similar to that which a composer produces. This is not possible with a novel or a painting and is even less so with a film. There have been those, like Boris de Schloezer, the great French scholar of Johann Sebastian Bach, who distinctly separated aesthetic aspects from the artist’s act of creation, claiming that the analysis of the latter is the work of psychologists. Massimo Mila instead maintains that it is not psychology, but the analysis of the historical conditions of creation that can help us better understand the genesis of a work of art:

"We believe it is possible to preserve the purity of an aesthetic concept of music, unpolluted by psychologisms, without renouncing the reality and concreteness of historical values."  

The fact is that artists do not respond to questions in the same way that scientists do. Artists do not interrogate nature by way of experiments, but rather simply produce answers in the absence of explicit questions. In these answers the nature of these artists is reflected, and through them they express themselves. As Mila says:

"Expression is a type of spiritual osmosis, above all an “unconscious expression” through which all the weight of an artist’s human personality, without their realizing it, passes into the piece of art they are working on."

A half century later Philip Johnson-Laird, professor of psychology at Princeton and who we will speak about further on, began studying the creativity expressed in jazz improvisation. He was able to simulate in a computer program the techniques of musicians capable of improvisation. The techniques involved processes of which the musician was unaware, or as Mila’s words, “they do not realize they are using them”. The mystery of the human personality remains, which according to Mila “passes” into their music. How does this passage take place? Traces are not left behind in the work of artists as they are in the work of

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4 Trans. Knaeble; original text from M. Mila, L’esperienza musicale e l’estetica, Turin, Einaudi, 1956
5 Trans. Knaeble; M. Mila, L’esperienza musicale e l’estetica, Turin, Einaudi, 1956
scientists. Artists not only do not ask “creative” questions, they do not even conduct “creative research”, in the scientific sense of the term. We have probably all come across the famous remark by Picasso, “I do not search, I find”. Outwardly it seems to have nothing to do with scientific creativity. In the case of scientific and technological training and education, one would have hoped to have been able to offer some suggestions, to have at least defined some processes for reproducing environments or atmospheres conductive to creativity. All this seemed unacceptable in the case of artistic creativity, which therefore rises to the level of mystery par excellence. Yet it is this mystery that makes all the difference, as Mila states:

We all know of musical compositions which are perfect in structure, in which all correlations are satisfactory and the only part that seems to be missing is that small detail which is beauty, namely the vivid imprint of a human personality clearly perceived.6

- **Exercise**: Imagine yourself listening to a piece of music that you enjoy and that moves you. Does it evoke personal memories or do you like it simply for what it is?

_A creation without a creator: Darwin’s revolution_

At the end of the 1800s Charles Darwin appeared on the scientific scene. His theory of evolution according to natural selection overturned the model that 19th century science had offered to future psychologists.

Darwin did not study inanimate nature, the seat of determinism, nor the negation of creativity as absence of freedom. Instead he grappled with the natural history of living creatures. His observations showed that this too was to be considered as a kind of history, even if a very distant one. He dealt with natural history and not cultural, but one which nonetheless always entailed a change over time, and a change in conformity with specific laws. In short Darwin hypothesized two mechanisms: variation and selection. The variation in a species, from one generation to the next, is random. It the case where variants are created within a species, hence the term _spontaneous variants_. These variants do not often adapt to the environment in which they live as well as the standard population does, and therefore usually become extinct. However, some of them, as an exception, turn out to be a better fit and are rewarded by the environment. Thus, the species gradually changes thanks to a blind sequence of rewards and punishments.

Darwin paved the way for scientifically dealing with a mystery which, until then, only artists had tried to unveil: the meaning of life. Recently, genetic science has begun to help us also understand the meaning of death. In simple organisms such as yeasts and fruit flies, and in more complex organisms such as mice, there exist something called “death genes”, which order the organism, at a certain point, to “commit suicide”. In this way the average life shortens and genetic evolution accelerates, generation after generation. For instance, if the temperature of the earth were to suddenly grow a lot hotter, the selection of spontaneous variants which could tolerate the new environmental conditions would be highly important. On the other hand, if our lives were to last, let’s say, a thousand years, there would be less probability of variants emerging which were better fit for increasingly hotter temperatures. By eliminating the death gene, Italian scientists working in California, like Valter Longo and Paola Fabrizio, were able to triple the life span of yeasts. In addition, they were able to

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6 idem
simulate the damage that would occur to populations of organisms who lacked the death gene. For example, the development of a capacity for resisting epidemic diseases like AIDS would be reduced. This, we know, is how the indigenous populations of America who came in contact with European colonizers went extinct.

The theory of evolution, briefly mentioned here, has significant implications for the issue of creativity. The theory envisages a series of mechanisms which produce and eliminate new living creatures without assuming that behind these processes there is any form of volition. It is the case in which variants are created. It is from greater or lesser adjustment to the environment that some variants go rewarded or punished. What appeared for centuries in nature as the miracle of creation, the achievement of perfection for every living species, is the product of “blind” mechanisms which had operated unperturbed and without interruption for ages. In this sense, the question of creation is a chimera. But let’s pose an essentially psychological question: why do we prefer to believe that there is a Creator? What cognitive function promotes this mental and collective construction? Intuition, which at the beginning of this assumed inevitable – for a creation to exist there needs to be a creator – is no longer really the answer. Yet we still need to believe in the existence of a creator in order to avoid the mystery of cognitive structures generating innovation (we will look at more closely in the last chapter). As we will see, technological innovation is the prototype of creation in the absence of a clearly recognizable maker, and involves anonymous and diffused processes. Also with the case of manufactured goods, the product and result of complex organizations, when we need to communicate we often try to invent surrogates, namely product trademarks and company names, in order to say that McDonalds created the hamburger.

- Exercise: Try looking around you. For how many objects or living beings do you know the process of their generation, even if only approximately? And the name(s) of the people who created them? Is there a difference between the objects for which you know the creator and those for which you do not?

In the case of art a similar question is posed. How can we make a statement on the inherent creativity in a work of art? In the second half of the 19th century, when our story of innovation and creativity begins, certain scholars like the German Theodor Lipps, theorized about a sort of empathetic ability based on an alleged constant of human nature. This empathetic capability was the source for evaluating and assessing the creativity found in a work of art. For many years there was much debate as to the nature of this source. Was it a form of direct experience, an immediate intuition, or an instinctual mechanism? At the end of the 19th century the notion of instinct was used by William James to classify all types of behavior into two forms: voluntary and automatic. The latter of these were neither learnt nor guided by conscious motivations. On the contrary Darwin considered instinct as a characteristic of the species, and not of the individual. Darwin’s idea was met with much success, in fact, too much. In a review published in the “Psychological Review” (The Misuse of Instinct in the Social Sciences) and in a subsequent book published in 1924, the American psychologist Luther Lee Bernard showed how more than 400 authors had listed over 500 different types of instincts. Decisively too many. On the other hand, historians and philosophers of art refused a psychologistic explanation of “artistic volition” as a sort of universal artistic instinct. This notion, also called Kunstwollen, was introduced at the end of the 19th century by the Austrian scholar Alois Riegl, to indicate the creative powers which are expressed in a work of art and grasped by the observer. During the debates of the 1920s, this notion was easily rebutted by
scholars like Erwin Panofsky (the renowned author of *Prospective as Symbolic Form*, born in Hanover, Germany and immigrated to New York in 1935):

[…] this empathetic act represents the direct experience of an empirical subject or of a certain number of empirical subjects, conditioned by taste, education, environment, and by the trends of the time… the empathetic experience of certain men and not of simpliciter man.7

Hence there only remained historical method, description, classification, and comparison; all of which was unessential, in Riegl’s opinion, for describing the power of creation.

Other psychologists were active in that same period. Sigmund Freud was attempting to overturn ways of understanding the psyche: unconscious mental life is the domain of desire; forgetting certain conscious matters is as important as remembering them. Thus, pathology became the key to understanding normality. By adopting this metaphor artistic creation was understood as a result of a shift in forces in the domain of desire, or in other words in the unconscious. This was the fuel that fed artistic creation. The motor worked well thanks to all the rest: technical skills, cultural and artistic influences, the spirit of the times, and so forth. Despite the efforts made by Freud at interpreting single works, the level of his explanation had more to due with the motivations of artists than with the nature of individual works. It still remained a mystery how even a failed work, or the work of an inept amateur, could be generated by the same unconscious forces that were thought to be involved in creating a masterpiece.

On a very different level, the same criticism could be directed at whoever had established the devices and methods for deconstructing the perceptual mechanisms incorporated in a visual work of art. This was the pioneering work of Rudolf Arnheim, the great German scholar of the relationships between art and perception, who had emigrated in the 1930s first to Rome, then to the United States. Arnheim probed all the mechanisms used by artists when creating not only perceptual effects, but also emotional ones. It was a matter of using the laws of perceptual organization, whose existence had been proven by the ingenious experiments of the German school of *Gestalt* (i.e., *organized form*, in the sense that the *formal conditions* of perceptive organization were investigated independently from their meanings or in other words from the effects of past experience). Here we are dealing with instruments which are more specific than those outlined by Freud. However, they too are applied to man “in general”, given that they are based on the functioning of his perceptive and emotional apparatuses. Now we can finally speak of “simpliciter man”, to use Panofsky’s words. However, the *Kunstwollen* is lost, and that is namely the interweaving of forces which animates a work and arouses empathy in the observer. As Roberto Casati noted years ago, it is an intriguing paradox that the Gestalt theorists left more of an imprint, in the art of the last century, through their scientific demonstrations than through deconstructions à la Arnheim. In *optical art*, and in artists like Bridget Riley, we find the optical effects, whose origins the Gestaltists had mapped out with great difficulty, widely used still today. Take for example the installation *Weather Project*, an artificial sun created by Olafur Eliasson. This sun illuminated the atrium of the Tate Modern in 2004 and became the most visited exhibition of a living artist in all of history. The sun gave off a luminous mist and created a *Ganzfeld*, a phenomenon described by Gestaltist Wolfgang Metger (1899-1979).

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Fig. 1. Bridget Riley, *Untitled*, 1964. Ink on paper: a work which exploits the energy produced by the bending of ten black stripes. The stripes change direction at the same place, creating an edge or border with the white space to the left. An application of the principles of perceptual organization experimentally-studied by Gestaltists.


Let’s try to construct a situation in which the light energy leading away from the perspective of an observer is identical in all directions: the observer begins to feel unpleasantly immersed in a mist that is growing progressively thicker. In an everyday context the state which most closely resembles the feeling reproduced within the Tate Museum, or within a psychology lab, is that of driving in fog at night. When the stimulation is perfectly homogenous, instead of finding ourselves in darkness, we find ourselves immersed in fog. The interesting thing about *Ganzfeld*, as a borderline case, lies in the fact that the central idea for a science of vision is optical information, intended as the range of non-uniformity in the distribution of light. In this way we are able to speak of the creative aspects of perception.

At the end of the 19th century Paul Cézanne succeeded in eliminating contours, due to the fact that contoured forms do not exist in nature. He thus obtained three-dimensionality through the use of color. Thanks to their difference in tones, patches of color which are placed next to each other are read by the perceptive system in terms of shapes and backgrounds. Cézanne applied this technique obsessively in his paintings of Sainte-Victoire, the mountain overlooking the eastern plains of Aix-en-Provence. He continued to paint the mountain from several points of view, and in various lights, for many years. The mountain constituted both a starting point and an obstacle. Creativity consists in producing numerous variants with the aim of gradually arriving at the essential. Cézanne unconsciously applied the theory of creativity which will be explained further in the last chapter of this book.

In the early 1900s Cézanne ended up choosing blurred contours and splashes of color which vaguely alluded to the elements of the landscape: trees, houses, aqueducts and the protuberances of mountains. Thus a process was initiated which drew closer to architecture and visual arts, finally reaching a sort of osmosis in the last decade. The meeting point is the formulation of visualized thought through the process of dismantling the mechanisms of perception and exploiting the creativity of our visual system.

To make this analysis less abstract, take a look at the two tables drawn by Roger Shepard below. If you measure them with a ruler you will see that they are the same size. To the eye,
however, they appear different. Vision creates. Artists are continually exploiting these creative capacities. Why was this type of creativity in designing visualized thought praised only in the last century and not before?

A visitor to the Salvador Dalí exhibition held at Palazzo Grassi in Venice in the autumn of 2004, could confront the optical devices applied by the painter with the perceptual system of the Mars Pathfinder robot which had landed at Ares Vallis, on Mars, on July 4, 1997. The Mars Pathfinder contained two cameras which transmitted three-dimensional images of the terrain to scientists on earth. Its 24 filters were used to produce colored images in order to help us better understand the composition of the planet. Some of the most interesting rock formations and sites found on Mars were given names like Wedge, Camper, Yogi, etc... Some amazing photographs of these places have been produced. Among the most interesting is Yogi, a rock whose profile, when in miniature, resembles Cézanne’s Sainte-Victoire. Nonetheless, Mars Pathfinder does not actually see anything, in the meaning we associate with that verb. The table below is how the Mars Pathfinder represents Yogi’s summit:

<table>
<thead>
<tr>
<th>147</th>
<th>138</th>
<th>145</th>
<th>156</th>
<th>142</th>
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<td>133</td>
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<td>178</td>
<td>187</td>
<td>196</td>
<td>193</td>
<td>195</td>
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</table>

This matrix of numbers constitutes only a small part of the photograph of Yogi. The numbers measure the lack of homogeneity of optical information from Yogi’s peak. Yet the numbers mean nothing to us. NASA used a program for transforming the numbers into patches of color from which arise objects, just as Cézanne did in his last paintings of Sainte-Victoire. If we transform the matrix by using a complicated algorithm, we can change the perspective from which Yogi is represented and, hence, how it is seen by an observer. It is as if we were to take a tour around Sainte-Victoire. Cézanne did just that, continuing to paint the
mountain from different perspectives. It was not until 1910 that Georges Braque and Pablo Picasso succeeded in eliminating this constraint from visual arts and produced images that simultaneously synthesized more than one perspective. The NASA algorithm contained different perspectives. In order to show them, it had to produce different images, just as Cézanne did. In the analytical cubism of Braque and Picasso, and of many others who followed, there operates a synthesis within the image itself. Unlike the art of photography, which was emerging at the time, Braque and Picasso produced their works according to the principle of simultaneity, where an object is seen and drawn in profile (from front, from above, from below, and so forth). Thus another constraint was eliminated in the history of visual arts, a history which reproduced the mechanisms of creativity perfectly. We will examine these mechanisms further on in this book.

Mice and labyrinths: creativity abandoned

At the beginning of the last century the relationship between the science of psychology emerging at the time and the question of creativity in its various meanings was not an easy one. Modern cognitive psychology had not yet been born. There were no available instruments for aiding the work of historians of ideas who were involved in analyzing the peaks of creativity in science. Regarding artistic creation, the crude attempts at weighing and judging aesthetic appreciation with the techniques of free association, and by measuring the aesthetic pleasure provoked by different geometric forms, had proven unsatisfactory. They resulted in ad hoc explanations, single case analyses, or were simply too generic. In other words, the specific mechanism generating creativity eluded them. Freudian psychoanalysis, intended as the description of mental facts, was simply a more refined theory of motivation, one that placed the intentions of man, or more exactly his desires, in a semi-accessible part of consciousness. It was a step forward because it dealt with the question of why a person, either artist or scientist, after having created something, was unable to explain through introspection how they had succeeded in doing so. This, however, is not wholly sufficient. As already mentioned, it is not enough to merely know where the petrol for your car comes from, above all if it spouts from some invisible pump. It is also necessary to know how the car’s motor works.

Generally speaking, psychologists in those times were not content with their methods of inquiry. Simple introspection, namely examining the contents of the consciousness, effected through self-observation or through consultation (with an expert, as Freud did), turned out to be unreliable. Excellent techniques for writing introspective novels in Proustian style, but dubious and uncertain methods for building a science. Instinct-based explanations for behavior were inconclusive, if not circular.

After the First World War psychologists radically changed direction. They set themselves limits and constraints, as did Ulysses in order to listen to the siren’s song without being led astray. Here is the challenge: can we really learn anything if we limit ourselves to recording behavior which is observable only under controlled conditions? Challenge within the challenge: let’s try to understand the simple case of a rat, before attempting the more complex case of man. Rats, like humans, must resolve problems they have never encountered before. Can rats, in their own way, be creative in their approach to the problem? If you put them, unfed, in a labyrinth, they will undoubtedly search for food. At first they will roam about at random, taking wrong turns, and then gradually, through trial and error, find the right path to
the food. In light of this example we can attempt to reproduce creativity, intended as the ability of solving problems. When the solution to a problem, for example that of feeding oneself, is not apparent, an organism will search for ways to resolve the problem. If the paths to problem solving are constructed in a laboratory, it is possible for an experimental psychologist to make them gradually more complex, with the intention of discovering what the result will be. In this way, a psychologist is able to study the ways in which different species behave when faced with increasingly complex problems. This is how comparative psychology was born, and more specifically, also a comparative analysis of the degree of creativity in various species. This method allows us to construct a kind of scale for problem solving abilities. A simple organism such as the moth, similar to the one fluttering against my lighted window at the moment, is incapable of circumventing an obstacle it comes across along a given path. It is unable to step back, in order to reach its destination or target by another means (the Mars Pathfinder robot was programmed to do this). Instead it seems natural for a dog chasing a ball in a yard to be able to perform this same task without problems.

Hence the question of creativity is dealt with through studying the processes of learning that develop when trying to solve problems which are increasingly complex. Processes of learning that concern the species or the individual. From this perspective, the bases for creativity are equivalent to those which compel us to satisfy a need. More complex creatures have more complex hierarchies of needs. A writer who gets fulfillment from producing a piece of work, has previously satisfied more basic needs and, therefore, is able to dedicate himself/ herself to the desire, or to a “transferred desire” in Freudian terminology (Eros is sublimated in the work). A hierarchy of desires, which in more simple animals comes to a halt very early on (natural survival), in humans continues to reach ever higher pinnacles. Are the notions of creativity and problem solving the same? If this were true, then there would be neither creativity nor curiosity without a goal.

- **Exercise:** Try observing an animal that you know well. How much of its behavior seems innate or the result of training, and how much seems instead to descend from its ability to resolve problems autonomously?

After World War I psychologists decided to call themselves behaviorists. They wanted to construct psychology as a science, restricting themselves to the comparison of behavior under controlled situations, at most in laboratories. In becoming behaviorists, they were inspired by analogous operations conducted by other behavioral sciences in pursuit of exactitude and simplicity. Economists had done something similar by transforming desires into preferences. In this way, they derived what an individual’s preferences were based on how they behaved and through the choices they made. The assumption is that people know what they want and are rational in their attempt to get it. Sociologists did the same by constructing theories not on the basis of speculation, but on data which was collected systematically and developed through statistical methods. Finally, political scientists laid the conditions for understanding domain of ideologies as a market for comparison and debate. Of course the problem of creativity and innovation lost its aura, but in return it became manageable and interdisciplinary.

As if to compensate for this reductive theoretical structure, psychologists became very imaginative in their invention of experimental situations. In general, and in order to study how rats learned to both discriminate among different stimuli and to take advantage of signals initially void of meaning, ever more complex and intricate labyrinths were built. It was an on-
going challenge. In 1925 John Frederick Dashiell, founder of the Psychology Department at the University of North Carolina, Chapel Hill (1921), used a labyrinth which, in its final version, consisted of a chessboard of nine squares intersected by numerous paths. Through this labyrinth he uncovered a surprising behavior could not be explained by the doctrine in fashion at the time. After finding the food and appeasing their hunger, the rats lingered to explore the new and “useless” zone of the labyrinth in which they found themselves. A mysterious behavior if one assumes that the motivational state of the rats prior to the exploration consisted of physiological needs, such as those of hunger and thirst. It was also necessary to assume that the rats’ motivation was due to something like “curiosity”, something that went beyond vital needs. The observations made by Dashiell were to be re-examined in the following decades by the two American psychologists Daniel E. Berlyne and Phil Zimbardo. Their methods reaffirmed that animals are not only able to solve problems but are also curious. And curiosity is the antechamber of creativity.

The work of the behaviorists was restrictive basically because the equation “creativity = solution to problems” excluded too many factors. However, in science, the actual stripping of problems to their bare bones at times is what actually produces good ideas. Behaviorists believed that learning was the result of a process of trial and error, a bit like Darwin’s model on the evolution of species. Creativity was the outcome of successful attempts at problem solving. Had things always worked this way? Already the necessity to explain behavior in the absence of need – and curiosity did not seem to be a need, at least without rendering the concept of need too vast – posed certain theoretical problems. Ensuing work showed that one could provoke not only curiosity in rats, but also what was called “irrational fear”, insomuch that it was not warranted by prior conditioning (that is, associations among rewards and punishment). The behaviorists had acted as novice magicians: the results obtained eluded their own theories.

The mind beyond the cage: creativity rediscovered

A brilliant Gestaltist psychologist, Wolfgang Köhler, was stationed at the biology station on the Canary islands during the First World War. It should be noted that the German Gestaltists did not get along well with the American behaviorists (although vice versa this was not true in view of the obvious imbalance in power: these were the first signs of the empire asserting itself). Regardless of the results produced by the rat-testing scientists, who got themselves into a fix over curiosity and irrational fear, Köhler wanted to demonstrate that thought was not always only reproductive, but productive as well. Such terminology was coined during the ongoing dispute with the behaviorists. How did behaviorists define creative thought? They said it was the ability to reproduce a sequence of steps which were discovered through trial and error and by a system of negative and positive reinforcement. There are two types of problems: those which we know how to resolve, in the sense that a series of movements acquired from past experience are available to us; or those which are new. In the case of a new problem, we proceed through trial and error testing until we decide upon an effective strategy. The solution to the problem is in this way gradually discovered with the passing of time. There is no doubt that in many instances this is how things work also for humans: finding the right key from a bunch, finding a destination in a new city when you are without a map, getting your bearings in a new work environment, etc... Have you got the idea? Not true creativity, but attention, tenacity, and memory. What seems creative or sublime to us is -
according to the behaviorists - the fruit of these ingredients. On the other hand, many artists and scientists such as the writer Calvino or the scientist Faraday”, give descriptions of their work activities that are more similar to those of a methodical clerical worker, than to a “brilliant and wild” artist. The result of this process can be absolute perfection, however difficult it was to reach it.

- Exercise: Think about yesterday or last week. Did you come across any problems which you were not able to resolve immediately? How did you solve them? Did you resolve them through trial and error, or did you stop your methods in order to look for a solution? Did you try to recall similar problem you had had in past experiences?

Is thought always reproductive when you work? Are you ever able to produce something new without the help of a gradual, step-by-step process which includes trial and error? These are the questions which Köhler posed. To fight his enemies, he moved onto their territory: animal behavior. Köhler did something which today seems rather common. We have seen endless television documentaries where contexts are created within natural environments so as to help show us how animals live. Amongst the multiple aspects of the lives of animals, Köhler was interested in their ability to resolve problems. He systematically observed the behavior of chimpanzees when placed in situations which required problem solving. For example, the task of obtaining food placed outside their cage or hung from a ceiling. Inside the cage a stick or a series of boxes would be placed which were either too short or too small to be used by the chimpanzees for reaching the food directly. After what initially seemed to be “stupid” attempts, the chimpanzee resolved the problem by either using the short stick within the cage to reach a longer one located outside the cage, or by placing the smaller boxes on top of the larger ones so as to build a type of ladder or step. In conclusion, the chimpanzee, in particular Sultano - Köhler’s favorite, succeeded in finding a solution not through trial and error, but through an act which we might call “creative”. Köhler and the Gestaltists called this act insight (Einsicht in German; literally to see inside, but also to glimpse, in the sense of ‘glimpsing a solution’). Insight means seeing inside a problem, understanding the functional aspects existing among the elements and relationships of a situation, and resolving the situation with a cognitive act of “ restructuring”. This is where cognition is to be found, in the relationship between mind and world. The mind extends and reinterprets the situation. The creative act is restructuring.
2. Creativity, discoveries and innovation

Re-inventing the umbrella: the processes of restructuring

If the behaviorists were recognized for having defined the criteria which established a line between creative and non-creative solutions to problems, then the Gestaltists should be recognized for having explored the terrain which lay beyond this border. These are the points which Köhler demonstrated:

- not all forms of learning take place through trial and error;
- when an animal has a goal to reach, it may do so by inventing a new strategy;
- there is no clear-cut division between creative and non-creative solutions.

The third point, that of graduality, is a crucial one. For example, there are animals which are able to use instruments for procuring a desired object and there are animals which are not (fig. 3). Some animals are capable of stepping back from their goal in order to reach it by another route, while some animals are not (fig.4). By combining these two situations more complicated forms of circumventing can be constructed (fig.5).

Fig. 3. A T-shaped stick which the animal can use for procuring the piece of fruit (use of instruments).

Source: Figures 3-11 were taken from G. Kanizsa, P. Legrenzi and M. Sonino, Percezione linguaggio, pensiero: un introduzione allo studio dei processi cognitive, Bologna, Il Mulino, 1983.

Fig. 4. p₁: the direct route: shorter but obstructed; p₂: the route which initially withdraws from the goal, so as to reach it via another route (circumventing).
In this chapter we will speak about the mechanisms of restructuring. To confront the problem of creativity from a Gestaltist point of view we need to answer such questions as: When one restructures, how does one do it and what gets restructured? The work of the Gestaltists is an indirect confirmation of the Darwinian revolution or of the unification between all life forms. From the point of view of creativity, there exist quantitative, and not qualitative differences between humans and animals. And not only: a man who goes through life without ever having to resolve a new problem – and today this is almost possible due to technological and social progress – is less creative than a monkey forced to invent a new method for procuring food. Here are two admirable steps made by Darwin:

Still however great the difference that passes through the minds of humans and that of more elevated animals, it is only a difference of degree and not of quality. For my part, I can conclude that among all the causes which produced differences in the outward appearances of the human race, and up to a certain point between man and other animals, the choice of sexual preference has been much more effective [...]. I believe that the effects of habit are secondary in importance for natural selection when compared to the effects which can be called spontaneous variations of instincts, that is the variations produced by the same unknown causes that produce the tiny deviations in the body.\(^8\)

Chance and spontaneous variants: Darwin taught us not to place too great a distance between man and other life forms; Köhler threw a bridge over this distance.

The results of the Gestalt approach are remarkable also for another reason. They show us that creative strategies (or productive strategies in Gestalt parlance), and non-creative strategies (or reproductive strategies) do not exist at all. At school we were taught to consider the great scientific inventions and artistic masterpieces of history as prototypes of creativity. And so they are, in that they represent works of the intellect, creative excellence, and the best a civilization or culture has to offer. In spite of this, from a psychological point of view, a creative person is also a person who reinvents a solution without realizing. Say that an individual is faced with a problem for which they have no past experience in resolving. In order to solve it they can make use of a strategy which has already been used by others but of which they are unaware. This, however, does not spare them from needing to exercise cognitive restructuring.

\(^8\) Trans. Knaeble; text found in V. Somenzi et al., (ed.), \textit{Il Posto di Darwin nella storia della psicologia} (Proceedings from the Centennial celebration of the Death of Charles Darwin), Istituto di Psicologia, Università di Siena, 1982
In conclusion, the level of creativity required for moving about in a social context depends on the life history of a person, or better, on their past experiences. This explains how a business or firm may seem to a newcomer an unknown world rich in surprises and discoveries, while to an expert it is just a boring routine. If the right people are placed in the right positions, a “mature” company requires hardly any, if zero, creativity in order that its routine activities be carried out. However, competition for the production of innovation between companies is quite different.

- **Exercise:** Do not think that you will always find solutions to problems in past experiences. Look at the experiences of others and seek advice. If you do not come up with anything, try identifying the elements of the problem and its structure.

Creativity is restructuring. What does this term mean exactly? What exactly gets restructured? Answer: the elements of the problem. So why is restructuring creative? We will soon see how we are unable to creatively overcome an obstacle when we search for the solution without concentrating on the problem. Creativity consists in getting rid of the disguises with which the problem presents itself, in isolating the components and in reinstating them in a new structure. From here the solution emerges. However, this is easier said than done.

*Asking the right questions: creative restructuring*

Let’s examine the first type of problems, those which psychologists call “closed” in that all the necessary information for resolving it is available. In these cases, being creative means solving a ready-made problem without having to search for extra information.

Let’s consider an example first studied by Van de Geer, a Dutch psychologist, and then taken up and re-examined thoroughly by the Italians Giuseppe Mosconi and Valentina D’Urso.

Here is the problem:

A man works in a city. Every day after work he takes the same 12 o’clock train back home where he is met by his driver at the town station. One day he finishes work early and takes the train that arrives at his hometown station an hour earlier. He begins to walk towards his house. Along the way he meets the driver who is heading to the station to pick him up as usual. The last stretch of the journey the man takes by car. In this way he arrives at home 10 minutes earlier than usual.

How long did the man walk for?

Presented in this way, the problem is difficult (not even a tenth of the people interviewed were able to resolve it). If a person is intent on solving it in this way, they get bogged down. The creative operation consists in isolating the crucial pieces of information from the final question:

1. the man leaves at 11:00 and begins walking home;
2. the driver leaves in order to arrive at the station at 12:00;
3. the driver saves 10 minutes (i.e., 5 minutes on his way to the station and 5 minutes on his way back from the station);

[4.] 12:00 minus 5 minutes = the driver meets the man at 11:55;

[5.] solution: the man walked for 55 minutes.

In that sea of initial information, the important data can be found in points 1, 2 and 3. From points 1, 2 and 3 one should then infer [4] and [5]. Mosconi and D’Urso constructed a version of the problem wherein the crucial information is not implicit:

A man works in a city. Every day after work he takes the same 12 o’clock train back home where he is met by his driver at the town station. One day he finishes work early and takes the train that arrives at 11:00. He begins walking home. Along the way he meets the driver who has left at 11:30 in order to arrive at the station by 12:00. The last stretch of the journey the man takes by car. He arrives home at 12:20 instead of at the usual hour of 12:30.

How long did the man walk for?

What has changed in this version? It stated explicitly that the driver left at 11:30 and arrived at 12:20 instead of 12:30, thus saving ten minutes with respect to his usual time. People who were posed this problem, were asked the following questions:

- How long had the man been traveling from the time he got off the train at 11:00?  
  *Answer:* a total of 80 minutes (he left at 11:00 and arrived at 12:20)

- How long was the driver’s total trip?  
  *Answer:* 50 minutes, 10 minutes less than usual.  
  Hence: 25 minutes there and 25 minutes back.  
  *Solution:* 80 minutes minus 25 minutes (the driver’s return time) = 55 minutes.

The people interviewed found this version less difficult. In fact it calls for no cognitive restructuring. And it is still easier, as you can see for yourselves, if the version is accompanied by a graph such as the one below:

Departure 11:00, driver 11:30, met 11:55

<table>
<thead>
<tr>
<th>on foot = 55 minutes</th>
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<tbody>
<tr>
<td>from 11:55 to the arrival at 12:20 (saved 10 min.)</td>
</tr>
<tr>
<td>by car = 25 minutes</td>
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</table>

The visual diagram corresponds to the mental model of the problem. If the mental model is complete, the solution is self-evident. A well-structured problem will present the solution by itself. It follows that the difficulty is not in finding the solution, but in posing the right
questions, in restructuring the problem and rendering it solvable, as well as in constructing an adequate mental model. In this way the solution becomes clear, as in the exercises of the Gestaltists after “perceptual restructuring” has occurred.

What this example shows us is how essential it is to see things from another point of view, to change perspectives, and to ask the right questions. The various components of the problem are taken into consideration and one must try to restructure them in view of the goal.

Be careful: it is said in view of the goal and not in view of the way that comes most readily. What is the most spontaneous way in the case of perceptive organization? That which leads to good form? The great psychologist from Trieste, Gaetano Kanizsa, demonstrated how this natural tendency can lead us off track. With six pieces of cardboard cut up as shown in figure 6, try to assemble a square.

People usually begin by connecting the pieces as shown in a. Whereas, the solution to the puzzle is reached by proceeding as shown in b (fig. 7).

Kanizsa observed that the combination a is “pro-structural”, namely that it is required by the figural properties of the two trapezoids. Indeed, they form a regular L-shape, with their sides making right angles. And yet the solution is reached via a different way (fig. 8).

The same happens when two of the six pieces have the shape of a semi-circle. People begin to construct a circle and are led off track (fig. 9).

Fig. 6. The six pieces with which one must form a square by juxtaposing them.

Fig. 7. Methods used for joining the two trapezoids in figure 6 so as to construct a square: the arrangement of a is more structural than the arrangement of b.
Exercise: Have you ever noticed that in order to solve a problem you need to go back, with respect to what initially seemed the obvious way of solving it? Were you able to go back, admitting that the initial way was the wrong one?

Until now we have used linguistic examples (the train journey) and perceptual ones. However, the type is irrelevant. The Gestaltists insisted on the general principle of restructuring. Figure 10 shows a geometric problem studied by Max Wertheimer, one of the founders of Gestalt psychology and the first to apply it to problem solving.

Fig. 9. The construction of a square by juxtaposing six pieces: people usually begin this task by forming a circle with the two semi-circles.

Fig. 10. Find the area of the square ABCD and the area of the parallelogram APCQ, by using the lengths given for the side of the square AB, and that of the two segments AP and CQ.
Seeing that the end goal is to find the area of a square and the area of a parallelogram, the traditional strategy consists in calculating the area of the square and adding it to the area of the parallelogram, for which we know the base and height (it coincides with the side of the square). The creative solution allows us to quickly see the overlapping of two triangles in the overall figure. One need only multiple DC (the base of the square which is also the base of the two triangles) by PD (i.e., AD+PA).

The moral is clear: do not stop at the spontaneous presentation of a problem or at what appears to be the obvious solution, resigning yourself to common rules or what has been done already. Think about it for a moment and then try to find an uncommon solution.

"Why do it in this way?" How many times in a workplace setting have we heard an answer like: "Because we’ve always done it this way." This reply is not a defense mechanism, nor is it a reaction to authority or to an inquisitive question. It could also be this, but at the base of the mechanism lies a cognitive tendency to repeat past routines, to do exactly as one has always done in the past. For example, let’s try to present children with the task (in the form of a game) of tracing the route to “M” in the following labyrinths (figure 11).

In the labyrinth to the left (a), the target “M” may be reached only by way of a long and torturous route, unlike the direct route in the labyrinth to the right. However, if you give children an initial series of routes like the one in the labyrinth on the left, they will tend to transfer this strategy also to labyrinths which resemble the one on the right (b).

The examples discussed thus far and more generally those used by the Gestaltists are of the closed and well-defined type. We discovered that the key lies in restructuring the elements through insight. These problems are closed and well-defined for the following reasons:

1. a person need not search for extra information, but restructure the information provided;
2. there is only one correct answer and this will be indicated;
3. there may be more than one way of solving the problem and some ways are more creative than others.

If you observe a person who is concentrated on a problem (or if you examine yourself), you may be able to see when insight occurs. Coinciding with the moment of liberation, with the satisfaction gained in understanding how to resolve a situation, we experience what the Gestaltists called *aha-Erlebnis* (or *Eureka!*), that feeling of “ah-ha! I get it!” produced upon finding an answer or solution to a problem. Having presented these examples many times in the classroom, I would like to add another indicator: the moment in which the eyes of your listener light up. Rather than worry about what people say, pay attention to their eyes. The eyes do not lie. When they grow bigger in a controlled, yet satisfied, smile, then you can be sure that the person you are talking to has received some insight, has restructured, has got the point. If I am teaching a class where there are at least a few company managers, it often happens that upon finding a solution to a problem I have posed, they will remain silent, so as not to appear too far ahead of the class, until their colleagues also arrive at the solution.

- **Exercise:** Try to remember the last time you faced a problem for which you did not have an answer. Did the answer come to you while you were thinking about it, or all of a sudden and by surprise.

We have already mentioned the contribution of the Gestaltists. They reproduced the experimental conditions for creativity which are called for in situations that contain closed and well-defined problems. However, in ordinary everyday life, the problems we face are usually not ready-made like those we face at school or when doing puzzle magazines. Even more interesting and realistic are the scenarios in which an individual does not have the available information at hand, nor do they come across it in their search. Here the individual is forced to unearth the information through more or less creative search. How do they do this? (and again, is an individual capable of seeing a problem where others were unable to?) At times the key lies in asking the right questions. From there the solution follows. We will return to these questions in the next chapter.

**Discoveries, invention and creativity**

Let’s set aside for a moment the work conducted by the Gestaltists between the First and the Second World Wars. It is interesting to note that many of the Gestaltists, having been forced to leave Nazi Germany in the late 1930s, emigrated to the United States where things were relatively better. World War II stimulated research in the field of psychology, above all in the analysis of the relationships between humans and war machines (e.g., the radar and anti-aircraft artillery). Gigantic advances were made in the field of technology. After the war, amid a society of mass consumption, there not only existed the problem of finding technology which was indeed new for manufacturing and products, but the products must be developed incessantly in order to make them *appear* new. How does one invent a new form, a new package, or a new look for an already well known product or object? If the modification does not truly improve the way the object functions, then we must content ourselves with an aesthetic, or communicative, renewal of the product. Sometimes it is necessary to pass off this latter kind of renewal as a sort of functional improvement. The difference between the two is not clear-cut. For example in designing a new spout for a coffee pot, or a new form of packaging, and then trying to demonstrate how this new modified version improves the
product’s overall function. This is where the more general problem of creativity, in relation to form and function, comes into play.

When mass consumer society came into being, form followed function, and the futurists celebrated the beauty of machines. New technologies are still today deemed as having aesthetic value, just take for example racing cars or fighter jets. Exterior changes then followed in the absence of structural innovations: the birth of marketing and advertising. In the case of standardized, mass consumer products, it is not the product which we end up seeing, but the product’s communicative or advertising message. It results in a splurge of para-creativity or pseudo-creativity; so much so that for the first time in the history of mankind we have a profession carried out by people who are thought of as “creatives”. These are the people who in advertising agencies are expected to come up with new campaign ideas for “creatively” conveying products. We all know of a similar story. I am sure that everyone has watched some amount, whether great or small, of television advertising. In this new world psychologists are asked to invent suitable techniques for nourishing, arousing, animating, and bringing forth creativity and to do so in order to produce new ideas, or at least the appearance of new ideas.

Psychologists established two types of methods for applying the techniques used for “renewing” products in relation to marketing objectives:

1. free association methods: both by directly questioning consumers, as well as through “expressive” combinations aimed at evoking new ideas (for example, associating a famous personality with a marketed perfume, so as to suggest the unique expressivity of that fragrance);

2. brainstorming and other forms of exchanging ideas, meant to bring about restructuring.

The technique of free associations basically consists of asking questions, to yourself or to someone else, of the type: “This here….what does it bring to mind?...and what else?...and?”, continuing like this until you have exhausted the question, or until your mind is blank. The effectiveness of such a technique is due to the fact that we are not aware of how our cognitive processes work, above all when they have expressive, emotional or sentimental value. Sir Francis Galton made use of the technique at the end of the 19th century when he used it for finding out how much information remains buried in our memories, at least if not called forth by the use of similar procedures. Do you remember the old and over-used passage from Proust where he recalls the scent of the biscuits he used to have as a child?

The technique of free associations was taken up again by Freud and by Carl Gustav Jung, the latter of whom also dealt with the problem experimentally. The goal was to induce patients to confess to things that they were not aware of or “did not want” to remember or admit. In advertising and marketing strategies this technique is used to reveal new, unusual and imaginative associations. Such associations can serve as cues for refreshing the advertising message of a certain product or service. Visual aids which associate different concepts (for example, forms of eyeglasses, designer brands, clothes, models, social contexts, etc…) can also be shown to selected individuals in order to study each person’s natural reactions to these associations. Something similar happens when we ask ourselves if a certain tie goes well with a certain shirt or jacket, etc...
Exercise: Write down the names of all the American cities you can remember. How many did you write in 1 minute? in 5 minutes? in 15 minutes?

Brainstorming is essentially founded on the Gestalt idea of restructuring. We have seen how a problem is often presented in a form which induces us to adopt customary or apparently obvious solutions, inasmuch as their having already been used in the past. These are not always “true” solutions. Sometimes they are just a way to rid ourselves of the problem. People hoping to propose good ideas often forget how the problem was initially presented to them and, abandoning all forms of professional reserve, share the very first ideas that come to mind regardless of seeming bizarre or ridiculous. Often ideas such as these, which are considered insignificant or irrelevant by those suggesting them, are those which the other members of the “creative group” find as innovative, inspirational, or novel with respect to what the competition has done thus far.

Exercise: Think of something that interests you or something that worries you. Write down everything that comes to mind, idea after idea. Does the outcome surprise you? Have you created associations without realizing it?

In this new world characterized by a splurge of pseudo-creativity the old boundaries dissolve. How does one classify a brilliant advertising idea or the work of a famous “creative person”? Shall we consider it a discovery or an invention? If it is interpreted as an “original idea”, then we can call it an invention, as well as a discovery and/or harbinger of general future trends in style or taste. When you are dining out and the waiter asks you if you prefer sparkling water or “Perrier”, are you led to believe that a new category of mineral water has been invented? Or that a new consumer brand has come out? Or does it make you think of the Gino Bramieri commercial which was a part of the Italian television show “Carousel” from the 1970s? This commercial was aimed at glorifying an ingenious innovation in fine chemistry: the Moplen (a version of Tupperware). This new material revolutionized kitchen and dining ware. The Bramieri “housewife” also symbolized a radical change in Italy, preempting the entrance of the “male” into the kitchen and in a certain way the road to a more equal status between the sexes. The discovery of this new trend of ‘man in the kitchen’, with respect to the traditional one of ‘woman in the kitchen’, coincided with the technological innovation of the new material. Another example is that of the fairly recent Italian television commercial for Lavazza coffee. Here the traditional idea of paradise on earth is inverted and instead an earthly pleasure (e.g., drinking coffee) is enjoyed in the setting of Paradise. Let us note that the Greek word for paradise, Paradeisos, was derived from the Persian Pardes, or munificent garden. The Lavazza commercial creatively exploits the fact that in the three most common Abrahamic religions (i.e., Judaism, Christianity, and Islam), the state of beatitude depicted in scenes like the Last Judgment, or in the resurrection of bodies, is most often portrayed in terms of earthly delights (e.g., gardens, tenderness, freshness, fruit, and in Islam even erotic pleasure).

In the centuries prior to the industrial revolution, true discoveries were due to the ability to uncover something which was already in existence but which had not yet been revealed. Discoveries may also occur by mere chance or through lucky coincidence. For example, while Columbus was searching for a new way to reach the Indies, he discovered America. The history of science is full of examples of this kind. Robert K. Merton coined the term serendipity in relation to the relative phenomenon (taken from “Serendippo”, the name for Sri
Lanka cited in the 18th century Venetian story, *Peregrinaggio di tre giovani figliuoli del Re di Serendippo*. The story is about three boys who make incredible discoveries in unexpected ways. In this sense the prototype for whoever makes a discovery, whether by chance or intention, is the explorer. However, the laws of nature also played a part: they were merely waiting for a genius to discover them. The world had functioned according to the laws of Newton even before that great English scientist set them down. As the poet Alexander Pope so accurately wrote: “Nature and Nature's laws lay hid in night: God said, ‘Let Newton be!’ and all was light”.

Thus, it involves discovering something new, which was already in existence at the time of discovery, with tenacity (the explorer of new lands) or with creativity (the phenomena of natural science). In the case of technological innovation we are certain of one thing: creativity produces something which did not exist before, not even as an idea. And it is produced in various ways. For example, the invention of the pull-tab for soft drinks or beer cans was an *aha-Erlebnis (Eureka)* type of invention (at least according to the creator). The same happened with correction fluid, or liquid paper, invented by an American typist who was tired of having to retype page after page of mistakes. Naturally there are other inventions which can be found in that intermediate ground between functionality and communication, and which are similar from a “cognitive production” point of view, only more immaterial. Take for example hair conditioner, a beauty product which leaves to shampoo the traditional characteristics associated with washing one’s hair and appropriates the cosmetic features of smoothing, combing and blow-drying. Even less creative, and based purely on a superficial communication process, is the operation of regrouping products once consumer needs have been established (what marketing professionals call the *product’s promise*). The result is a single product (shampoo-conditioner) which combines both speed and simplicity.

There also exists the enormous graveyard of innovations that have never been adopted and not necessarily because they are the results of repetitive, foolish, or simply “reproductive” processes. For example the shower bicycle whose pedals activate the spray of water, or the hat with built-in camera for taking photos discreetly, and so forth. The history of design is made up above all of projects that have never been realized. It is in this “land nourished by regret and disappointment,” as Maurizio Vitta observed, “where the deep-seated roots of those things which animate our world are studied”. In other words we must keep in mind not only the successful experiments, but also the results produced by error and mistake. Without the latter, the former would not exist.

On one side we have inventions which are technological innovations waiting to be put to use, such as the phonograph invented by Thomas Alva Edison (who was actually very disappointed when he discovered that it was not used as he had intended, namely for transmitting serious matters such as death reports or transmissions for the blind, but instead was used simply for transmitting frivolous music). On the other side we have “definite” technological goals that are reached gradually, through trial and error.

Let’s take for example the perfecting of the zip fastener or better known as the zipper. At the end of the 19th century high laced boots were in fashion but due to their laces were quite difficult to put on and remove. In 1893 the first patent regarding the zipper was registered and the general principle of the invention presented. It involved joining two flaps of material by connecting a sequence of metal teeth with the use of a sliding leader. The leader would not only fit the metal teeth into place but also separate them. It took many years, however, before the technical solution to this problem was found. The objective was clear, however an effective solution was still hard in coming. Gideon Sundback was the first person to solve
both the design and production of the mechanism (fig. 12). He approached the two problems (i.e., design and manufacturing) as if they were one. Keeping the objective well fixed in his mind, he thus succeeded in patenting the zipper in 1906 and then the machine for manufacturing it in 1915.

Another impetus for the zipper’s was the result of its adoption in military equipment during the First World War. And the final boost came from it being marketing by the Goodrich company, whose president - Bertram G. Work - coined it as the “zipper” in 1923. This marked the start of millions of models being sold every year.

- Exercise: Take a look at the technological innovations which surround you at home or at your place of work. Do you know the history of any of them, even if only vaguely?

The Gestalt theory on insight therefore does not apply to the technological development of many inventions, as seen with the zipper. The development of the bicycle or automobile is progressive due to continual improvements being made, or the processes of trial and error. At first numerous variations are produced, then with time and the application of operating tests, they are gradually reduced into just a few solutions adopted by many. If you are at all familiar with the history of the automobile, then you probably know that numerous models were tried and rejected before the beginning of World War I. Nevertheless, attempts at technological upgrading continued. Think of the futuristic Firebird produced by General Motors in the 1950s. Among the innovative features proposed for that model, neither the turbine engine, nor the single command steering wheel resembling an airplane control stick, met with much success. The only invention related to the Firebird which has survived today is the remote control for opening the car door. Here is a passage from Enzo Angelucci:

Today automobiles are already perfect machines - comfortable, safe, and fast. We seem to know everything there is to know about the engine, to the point of guaranteeing that such a small device can offer the power of ten horses. How long can man go on racking his brains over the engine? How long will it take before he considers it “old” and outdated, and begins probing into other new and unknown things?
It is easy to note the connection between invention (new) and discovery (unknown) in Angelucci’s words. The excerpt was written in 1962, the year in which I first received my drivers license! Since then the only true innovation that has been made in the automobile industry does not concern the engine, but rather electronics- a phenomenon no one had foreseen.

Creativity professionals

For many centuries the notion of creativity held a role only in theological disputes, as we have previously mentioned (Need there be a Creator for a creation to exist?). Today we come back down to earth. Creativity is now a central issue in a technologically advanced society and an intrinsic part of certain professions. However, if we take a closer look at Italy, for example, despite the emphasis on creativity incorporated in the Made in Italy motto, we must admit that the country is decisively not a leader in high profile and internationally well-known enterprises. Such enterprises originate from and amidst scientists and engineers, researchers and analysts, designers and stylists, writers and communication experts, software experts, finance and advanced technology professionals. According to assessments made by Richard Florida, professor at Carnegie Mellon, in Italy these types of professions constitute about 13% of the total job market, less than half of that of the United States, Belgium, Holland and Finland, and exactly half of that of Great Britain and Ireland. It is worth noting that the problem of diffused creativity, or high profile enterprises, cannot be equated to the percentage of GDP (Gross Domestic Product) spent on research and development. Sweden spends more than 4% on research and development, Japan almost 3%, and Finland 3.4% (2003). And yet according the surveys conducted by Florida, these countries have a lower percentage of high-profile and internationally-known enterprises than the U.S. However, we will soon see that the problem is more complex than this.

The analyses which Florida conducted for defining the framework generating these types of businesses are the sociological outcomes of a research process whose theoretical origins date back to the second half of the 20th century. The three crucial disciplines involve economics, the visual arts, and linguistics.

Let’s begin with economics. Its history is long but, as far as we are concerned, its crucial aspect is the market as a creative instrument capable of generating discoveries. As economist Stefano Zamagni also observed while commenting on the book Economic Sentiments written by Emma Rothschild:

The market is capable of utilizing knowledge which is dispersed amongst all the subjects due to the fact that it is basically a process of discovery […]and only by beginning with that act, is it possible to grasp the meaning behind the theory of market as spontaneous order.  

This observation is very interesting because it introduces a collective element into the processes of discovery. We will come back to this point later on. As regards innovation, Michele Salvati has made similar considerations:

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The market has won, and it has won on both fronts describable by the two basic paradigms of political economics: innovation and growth and that of efficient allocation of resources.

The market has always been noted as the best instrument for distributing goods and services from manufacturer to consumer in a diligent and low cost manner. However, in Salvati’s opinion, another and even greater advantage of the market is that it allows, or stimulates, an unceasing innovative tension among competitors. How else to explain this competition except through combining the trial and error mechanism of selection with the process of rewards and punishments administered by the market? Are not the two mechanisms of creativity that we mentioned earlier involved here? Joseph Z. Schumpeter made reference to these mechanisms when speaking of the powerful image of an “incessant turbine of creative destruction”, as did David Landes when, in 1969, he entitled his renowned essay *The Unbound Prometeus*. In the light of everything what becomes important from an applied and theoretical point of view is understanding how creativity spreads innovation in the world of business and industries (which is the chicken and which the egg?).

Another challenge, regarding creativity, marks the development of the arts. Here we witness the introduction of new technologies, such as that of cinema - certainly the most innovative art form of the 20th and 21st centuries. As concerns the visual arts, as has already been mentioned, anesthetists and art historians, such as Giulio Carlo Argan, have spoken more than once of “the end of art”, “the death of art”, and other variations of a concept we can trace back to Georg Wilhelm Friedrich Hegel (although the reference might seem somewhat inaccurate, if it is indeed true that one of his students, also a creator, invented it while preparing Hegel’s lecture notes!). Certainly we have little to do with art of former times, and yet contemporary art is more art now than it has ever been before, as Hans Georg Gadamer stated in an interview concerned with the presumed Hegelian concept of ‘the death of art’. To those who wanted to see art dead, contemporary art responded with a display of unceasing creativity, overturning past constraints and moving into a new cognitive-emotional zone on the strength of an ever-increasing inclination for dematerialization. The abandonment of material and of manual skill was made possible by the prodigies of scientific creativity: the computer, video projection, electronic display, and all other types of artificial technology. As we have already seen, the difference between creativity (artistic) and innovation (scientific and technological) seems to be diminishing on account of the intensification of the mental, cognitive, and software features which unite the two areas. In this way it became possible to propose avant-garde experiments such as Giulio Paolini’s presentation of a square piece of paper, Joseph Kosuth’s newspaper ads, Dan Graham’s published research on American homes, Mel Bochner’s pieces of paper which are “not necessarily to be considered art”, Daniel Buren’s reduction of band painting, Gilbert & George’s transformation of the painting into a performance of upright figures humming around a table, etc... Art, like science, should surprise. Both have been transformed into a kind of on-going performance.

We have emphasized how artistic creativity is characterized by its overcoming the obstacles established in past eras. Usually the moments which depict a breaking with the past are those that get emphasized, as we will demonstrate shortly. However, it is important to remember that something must remain in-variant in order for a discussion about a break with the past to make sense. Take for example the French artist Yves Klein who died of a heart attack in 1962 at age 34 (in 2004 an exhibition at the Schirn Kunsthalle in Frankfort displayed over one hundred of his works). Klein’s invariant was the color blue. With this color he painted the body of a model, who then became a sort of human stamp for making blue imprints on a white wall. He created this ‘living paintbrush’ at a large public happening which involved the
background music entitled *Sinfonia monotona*, a single note lasting twenty minutes and played by twenty cellists. The invariants were the paint brush (model), the surface on which he painted (a wall), the color (blue), the music (single note), and finally the artist himself. This latter invariant was described in these terms: “A painter need only paint one single masterpiece: himself, for all of eternity […]”. Artistic creativity, intended as the equilibrium between invariants and the breaking free of constraints, has a history which closely reminds us of the history of scientific progress as Thomas S. Kuhn reconstructed it in his classic book *The Structure of Scientific Revolutions* of 1962.

Artistic creativity drew nearer to scientific creativity for another reason as well. In today’s art world, in order to be able to express the authority necessary for activating the selection process of potential professional artists (reward = success; punishment = namelessness), only a small number of professionals in the field need have the required expertise. This is true also in the scientific fields where authority is the exclusive privilege of only a few hundred people throughout the world.

![Fig. 13. Yves Klein painting a model blue: the body then becomes a canvas and stamp for making imprints.](image)


In order to become more aware of this form of self-referencing, simply look up the word “scholar” on the *Google* search engine. There you will find citations from almost every scholar in almost every field of knowledge, from science to art, politics to culture. What is interesting to note is that the references to people who are listed more than once, and who are still living, often contain cross-references among themselves. Knowledge, in each field, is advanced on account of a community composed of relatively few people, a bit like with competitive tennis. And yet in order to create a league of top world tennis players, which consists of only a small number of champions, there need to exist millions of unknown amateur players. This iceberg-like structure, where only a few are sustained by the masses below them, is typical of all arts and sciences, as Howard S. Becker demonstrated in his
classic book *Art Worlds* (1982). If we pass from production to entertainment the circle widens slightly.

The reason why contemporary art has not become a product of mass consumption is due to it being compensated by cinema, television, and other forms of entertainment and communication. Contemporary visual art, on the other hand, is connected to artificial intelligence and the cognitive sciences. It is nourished, fed and interwoven by the externalization of the human mind in prostheses other and outside the human brain. As mentioned before, video, computers and other technological inventions are the support systems for an art which dematerializes through its passage from the exterior world to that of the mind of the artist or spectator. To support this is Douglas Huebler’s statement, published in the exhibition catalogue entitled *January* (1969):

> The world is full of objects of less or greater interest; I do not intend to add others. I would simply prefer to express the existence of things in terms of time and/or place. More precisely, the work deals with relating things which are beyond direct perceptive experience; understanding the work depends on a system of documentation.

In fact an artist’s work consists in creating events by restructuring existence, by constructing videos that record real events or scenes created *ad hoc*, or, as in the case of Huebler, by inventing unnatural classifications of objects and related events. For example, the project of the “42° Parallel” created in 1968. This work consisted of locating objects (sculptures) in fourteen American cities situated along the 42° parallel, and in producing a map and a collection of postal letters sent between the 14 cities. Another example consists in artist Lawrence Wiener’s declaration, made on occasion of the same 1968 exhibition above:

> Regarding the different possible uses of project works: 1) the artist can construct the work; 2) the work can be produced by others; 3) the work does not need to be realized. Each possibility is tantamount to and corresponds with the artist’s intention […].

Many more examples exist. What is important to emphasize here is the fact that a work of art tries to avoid reproduction, or becoming serial in nature, because it moves from exterior materialization to the intentions of the artist’s mind. It is possible that these intentions will never be accessible or revealed. Take for example the *Secret Painting* by Mel Ramsden (1967), consisting of an entirely black square canvas, joined by a side panel on which is written: “The contents of this painting are invisible; the nature and extent of the subject matter are to remain secret and unknown, except to the artist herself”.

In conclusion, if this is to represent a funeral for the death of art – as art critic Angela Vettese has pointed out – there are too many protagonists for it not to be fake. Also the funeral was invented to surprise. Nothing has died, or better still, art has died in order to be born again, as in the Schumpeter’s “incessant turbine of creative destruction”.

The only field where the notion of creativity becomes a vital theoretical support is in linguistics, or more precisely the revolution initiated by Chomsky which led to the birth of the cognitive sciences. Do you recall the behaviorists? From their point of view the linguistic ability of speakers and listeners is ascribable to a series of associations between words and meanings. These associations are the result of an infant learning its mother-tongue language. Noam Chomsky has shown that the ability to speak and understand a language is innate and based on the command of a complex system of rules. When we learn our mother tongue
language we are not aware of possessing or applying these rules. In fact we call “learning” something that technically is not learning. The human species has the innate potential for any natural language. When we learn our own language, it is as if we are pressing certain switches and in some way excluding other possibilities, in short preventing learning. Once certain switches have been blocked, it is difficult to switch them back on and return to the plasticity of infants. It is much harder for adults to learn a second language than it is for children. This tool-kit of rules belongs to the cognitive unconscious, one which is far more extensive and articulated than that described by Freud. We only know how to judge the results of these rules aimed at creativity producing language. We recognize if a phrase is poorly constructed and incomprehensible, but we do not know why (it is difficult to teach someone how to write well if they “do not have an ear” for the language). This ensemble of rules defines what Chomsky calls linguistic creativity: our ability to produce and understand phrases and discourse without having ever heard them before. If, in order to speak and understand each other, we relied on associations and not on the use of a few rules of production, this creativity would be impossible. To understand a phrase we would have to have heard it at least once before.

More generally speaking the cognitive sciences, born with the Chomsky revolution, are devoted to the study of limits, of restrictions, of what forces or coerces the functioning of our minds. Some of these restrictions are tunnels – tunnels of the mind, as Massimo Piattelli-Palmarini cleverly defined the term. Once inside these tunnels it is hard to get out. Also the other behavioral sciences were infected by the problem of “constraints”: Herbert Simon, the first cognitive scientist to win a Nobel Prize in economics (there is no Nobel Prize for the field of psychology; it is too new a science), speaks of bounded rationality. Economists Richard Nelson and Sidney Winter have demonstrated how an evolutionist approach, by way of trial and error, can be applied to economic growth. Michel Salvati observed:

The single agents which make up the large decentralized calculator of the competitive markets does not behave like the implacable and all-knowing maximizers represented by general economic balance... price indicators are not enough for making explicit choices of maximum advantage [...] agents make decisions under conditions of uncertainty and incomplete information, often on the basis of habits and routine, and often times end up being wrong.

Undoubtedly they make mistakes. Salvati made his prophetic statement more than a decade before the Nobel Prize was awarded to experimental economist Vernon Smith and to psychologist Daniel Kahneman. These two scientists built an ever-growing and active research tradition based on these systematic mistakes.

Why do single agents make systematic mistakes? Simon thought that the errors were possibly due to shortcuts which the limits of our minds force us to make: beneficial and effective shortcuts which, nevertheless, betray us at times. Kahneman is of a similar opinion in attributing the errors to cognitive processes, to the way in which information is elaborated. While others, like psychologist Gerd Gigerenzer and Leda Cosmides, believe that mistakes are made because we use strategies which were once efficient but are no longer due to the “unnatural” contexts in which we live today. The times of natural selection of species, hence that of the human mind, have entered into friction with the times of cultural selection. What once worked is no longer suitable for the modern world. Who is right is of little importance. For an analysis of the processes which lead to creativity, it is enough to say that these constraints of rationality undoubtedly constitute impediments or obstacle. They are what hinder or prevent us from having a complete and clear picture of the problems, a picture
which would lead to insight. They are what force us to simplify. Perhaps, at times, these simplifications are beneficial. Well-established routines hasten decisions and solutions, making them automatic. Yet they can also blind and dull us at times. They inhibit us from finding that way which, once traversed, in hindsight does not appear so creative to us. We are led to ask ourselves why no one had seen it before. This is a question which we will try to answer in the next chapter.
3. The obstacles in the way of creativity

The a-creative thought: focalization

At the end of the last chapter we mentioned some of the obstacles which stand in the way of creativity. When studying the processes of ideation it is important to consider why these processes are not easy and spontaneous. Asking ourselves why we are not able to do certain things can be useful for understanding how the human mind works. What stands in our way? What prevents or restrains us from finding intelligent solutions to problems? Gestalt psychologists posed the question but did not resolve it. However, over the past twenty years the cognitive sciences have begun to decipher it. We learned that it is crucial to examine the object of restructuring, namely the kind of knowledge in which the creative process is kindled.

It should first be said that the Gestaltists studied problems that were closed and well defined. All necessary information for solving such problems could be found in their formulation. In everyday life these types of problems are posed only at school or in puzzle magazines. In real life they rarely occur. Usually we ourselves formulate the problems and search for the adequate information for solving them. Here, in this phase of information gathering, is where the conditions for uncritical, narrow, and less creative decisions are established. This is where the trouble begins.

Let’s take the simplest case, one in which we must decide either to perform action A, or not to. What exactly are we trying to do? According to the theory of rational choice, we should calculate the consequences of our actions: if we perform action A what will happen? If we do not perform action A what are the possible alternatives?

Let’s suppose a friend has asked us if we would like to go to the movies tonight or not, allowing us to ask whatever questions we wish before giving our answer. It is usually quite natural for us to ask a lot of questions: What kind of film is it? Who is the director? Who are the actors? How far away is the cinema? Is there parking? What is the theatre like? etc... It is only when we have thoroughly explored all the options of going to the movies, weighed all the pros and cons, do we address the or not part of the question and give some sort of explanation. In short we proceed sequentially: first we inquire about A, and if A does not satisfy us then, and only then, do we explore possible alternatives. This is not a very wise way to proceed. It would be wiser to use our limited supply of ammunition to hunt down information regarding A and non-A. Otherwise if it happens that A satisfies us, we will never ask nor learn anything about non-A and perhaps miss a unique opportunity.

This common cognitive procedure benefited the present Prime Minister of Italy, Silvio Berlusconi, when, unknown as a politician, he decided to run for election just after having created (invented? certainly not discovered!) a political party in the course of a few short
weeks. Analyses of the political debates, in particular the final encounter with the opponent Occhetto, revealed that the majority of the discussions, whether positive or negative, revolved around Berlusconi. You might think this obvious: Berlusconi was a novelty at the time and the new phenomenon that people had to try and figure out. The attention was concentrated on him. Thus, excellent conditions were established for allowing the mechanism of focalization to come into play, that is, asymmetric research of information.

The fact that Berlusconi spoke well of himself does not surprise us (today less than ever). Instead it is interesting to note how focused Berlusconi’s adversary (Occhetto) was on his opponent, as if the dilemma were “to vote Berlusconi or not?”. In order to persuade undecided citizens to vote against his opponent, Occhetto spoke mostly about Berlusconi and his political plans, opposing him in mainly negative terms. This approach resulted in encouraging the majority of people who were less experienced, or less politically savvy, to go out and seek further information on Berlusconi. It makes one think. Only if unsatisfied, do you decide to do something different. The results were a preliminary advantage in favor of Berlusconi. Afterwards, through a study on voters’ choices and intentions was made, it became clear that those who had been uncertain of which candidate to vote for before the elections, were not, after voting, spread out between the two party alliances with the same percentage as those who had been certain of their choice. The majority of those who were initially undecided, voted for Berlusconi in the end. A similar decision-making process was witnessed in the Venezuelan referendum of August 15th 2004, which resulted in reconfirming Chavez presidency. The question posed was: “Chavez or not?”.  

The mechanism of focalization often blocks and dulls us in many, and above all critical, situations. It is exactly when we should be most open that stress and fear prevent us from being critical. For example, a research study published in the December edition of “Psychological Science” (2004) showed that if the U.S. population is strongly focused on notions of danger, or the possibility of death, they tend to choose a charismatic leader as opposed to other types of leaders. More generally, we can say that fear, or the finding oneself in a dangerous situation, contributes to halting one’s creative orientation, choice of options, or touch of adventure which has always been associated with innovation.

- **Exercise:** Can you recall any occasions when you had not thought of an alternative solution to a problem or situation and later regretted it? Did you explore all the possible options? Think about the decisions you have made in your life: what happens when you feel threatened or in danger?

Focalization exists but, fortunately, so does de-focalization. If you relax, after having concentrated on a problem extensively, you can establish the conditions for de-focalization.

A well-known English physicist used to say that the secret to creativity lies in the three Bs: Bath, Bus, and Bed. He had been racking his brains over a scientific problem for days without making any progress. Then when he stopped thinking about it any longer, and right before falling asleep – in the bath, or on the bus, or in bed – inspiration, insight, came to him unexpectedly. There are many autobiographical accounts written by scientists which tell similar stories: a long period of incubation, then, when one relaxes and stops thinking about the problem, the solution appears. It is the opposite process of what happens with focalization. When one is de-focalized all options are first explored, then they are left to settle, and finally, when one least expects it, the solution appears in the form of insight. This settling, or relaxing phase, is necessary if the conditions of restructuring are to be created.
In recent years many Italian investors have felt duped, or poorly advised, due to their having been persuaded to purchase shares which later proved unsatisfactory. As far as the investors were concerned, they had not made the decision to purchase the shares themselves, but rather “the bank had done everything”. Disappointed investors of this kind often make statements like: “The consultant asked me if I wanted to purchase share A or not. I decided to go along with it because of their advice. Then I discovered that …” What is significant here is the fact that an individual interprets a question like “Do you want A or not?” as actual advice. In turn, bank consultants usually defend themselves with a response of the likes of “But I asked them …. and they agreed”. In reality people tend to make decisions and to think “lazily”. Focalization is a constant trap. Therefore bankers are technically right but in effect wrong.

In sum up, we see that focalization stands as a powerful obstacle in the way of creativity and induces us, regardless of our intentions, to solve problems hastily and to simplify them in view of a quick decision. Hence, one tends to focus on the most evident and explicit possibilities at hand and disregards other points of views. In this way we distance ourselves from creativity.

- Exercise: Try to remember the last time you had collected a substantial amount of information on something before you made a decision. In your opinion, what did you base your decision and research on?

The a-creative thought: fixation

Let’s now examine other types of roadblocks to creativity which appear in cognitive styles which cause us to become closed, blinded, and uncritical. I will attempt to show how concentrating on our own ideas and hypotheses can turn into a form of fixation that prevents the problem from being solved. While focalization inhibits us from finding useful and necessary information, fixation blocks us in our ideas, almost as if we were wearing blinders.

Let’s try our hand at a type of game played with others. Show the following three numbers to a friend:

2 4 6

Explain that what your friend has to do is to find the rule which generated this sequence of numbers. You will have the answer written down on a piece of paper, which you should fold in two and give to your friend. The rules have been pre-established, but should be kept hidden so that your friend may check their answer only at the end of the game.

In order to discover the rules, the following method should be followed: your friend must provide you with another group of three numbers and, based on their answers, formulate hypotheses for possible solutions. For every set of three numbers that your friend presents, you should tell them if it is a positive or negative example of the rule (if it follows the rule or not). Only when the player is certain that their hypothesis coincides with the rule, basing it on the information received, should they present the hypothesis to you.

A multitude of similar experiments of this type, and with numerous variants to the problem, have been made. Psychologists specializing in human reasoning are concerned with the propensity for presenting sets of three numbers which confirm a contestant’s hypotheses, rather than sets which falsify them. This is an ineffective way of checking the hypotheses,
above all when the rule that needs to be discovered (i.e., three increasing numbers) is more general than the one which initially comes to mind based on the first example given (three even numbers which increase by two). Whereas for psychologists concerned with insight, what is crucial is the demonstration that the imagination is something other than creativity. Creativity is imagination but it is also rigor, method, reflection, pondering, and application of the intellectual mind. Only if we free ourselves of our fixations, can we trigger the necessary insight for problem solving.

Consider the following example of a test administered and recorded in 1960 at the College of London by Tirril Gatty, and taken by a literature student of professor Peter Wason (the inventor of the problem and indeed a creative type!). The mark shown between parentheses indicates the test examiner’s response each time the student makes a response: (+) stands for a “positive example”; (-) stands for a “negative example”. The answer to the rule is: “any three increasing numbers”.

<table>
<thead>
<tr>
<th>suggestions</th>
<th>answers</th>
<th>hypotheses considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 4 6</td>
<td>(+)</td>
<td>(set of three numbers provided by the examiner)</td>
</tr>
<tr>
<td>8 10 12</td>
<td>(+)</td>
<td>A series of alternate numbers</td>
</tr>
<tr>
<td>7 9 11</td>
<td>(+)</td>
<td>No change</td>
</tr>
<tr>
<td>7 5 3</td>
<td>(-)</td>
<td>Abandoned hypothesis</td>
</tr>
<tr>
<td>13 26 28</td>
<td>(+)</td>
<td>The second number is twice the first, the third number is the sum of the second plus two</td>
</tr>
<tr>
<td>8 16 18</td>
<td>(+)</td>
<td>No change</td>
</tr>
<tr>
<td>49 58 100</td>
<td>(+)</td>
<td>No change</td>
</tr>
<tr>
<td>8 13 15</td>
<td>(+)</td>
<td>No relation between the first and the second, but the third is the sum of the second plus two</td>
</tr>
<tr>
<td>1 2031 2032</td>
<td>(+)</td>
<td>Same as above</td>
</tr>
</tbody>
</table>

The rule is that “the first and second numbers are given at random, while the third number is the sum of the second plus two”. (wrong)

The student continued trying to solve the problem for a total of fifty minutes. He presented increasingly elaborate hypotheses and then finally gave up. The student showed to be both imaginative and at the same time aggressive. Based on his own thinking, he decided that the rule did not concern the sequence of the three numbers but rather the interrelationship between the three numbers. As Wason and Johnson-Laird observed:

Over the course of fifty minutes the subject formulated only three rules. At the end he arrived at a complex disjunction which largely retains a part of the preceding hypotheses. These are all clear indications of the fact that the fertile imagination and intense concern which the subject showed for the hypotheses previously put forth, restrict his grounds for evaluation, so much so as to make him blind to the obvious.\(^{10}\)

The answers to this problem are revealing, as with a litmus test, of people’s creative style. They show the difference between disciplined, attentive creativity and egocentric and fanciful play – a fertile but unproductive imagination. Here is a quite different example from the previous one. The problem was posed to a science student of Angela Fine in 1967. Rather than being obsessive and obstinate, the style is impulsive and shows that the student was in a hurry to settle the issue.

<table>
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<th>answers</th>
<th>hypotheses considered</th>
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</thead>
<tbody>
<tr>
<td>2 4 6</td>
<td>(+)</td>
<td>(set of three numbers provided by the examiner)</td>
</tr>
<tr>
<td>4 6 8</td>
<td>(+)</td>
<td>Add two to the first number and proceed as such</td>
</tr>
<tr>
<td>6 8 10</td>
<td>(+)</td>
<td>No change</td>
</tr>
</tbody>
</table>

The rule is to “add two to the first number and two to the second number”. (wrong)

| 8 10 12     | (+)     | A progression of positive whole numbers |

The rule is “a progression of positive, whole, even numbers”. (wrong)

| 13 15 17    | (+)     | Any three whole numbers |

The rule is “any three whole numbers”. (wrong)

| 3 5 22.5    | (+)     | Any three numbers |

The rule is “any three numbers”. (wrong)

| -11 0.999 22/7 | (+)     | Any group of positive or negative numbers |

The rule is “any group of positive or negative numbers”. (wrong)

| 8 6 4       | (-)     | The opposite of the original set of numbers |

The rule is “any three increasing numbers”. (correct)

The person spent a total of fifteen minutes to take this test. Each time he was sure of his rule. And to think that just a few attempts would have sufficed, had the student asked himself “Is the formulation of this hypothesis wrong?”, instead of wishing to prove his hypotheses. To check if one is wrong, one need only apply negative examples with respect to the hypotheses.

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11 Translator’s note: the litmus test is a test used for chemical acidity or basicity using a coloring material (litmus paper) that turns red in acid solutions and blue in alkaline solutions. It is a test that relies on a single indicator.
Here is an “ideal” test taker:

<table>
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<tbody>
<tr>
<td>2 4 6 (+)</td>
<td>(+)</td>
<td>(set of three numbers provided by the examiner)</td>
</tr>
<tr>
<td>2 6 8 (+)</td>
<td>(+)</td>
<td>Three increasing even numbers</td>
</tr>
<tr>
<td>7 8 10 (+)</td>
<td>(+)</td>
<td>Three increasing numbers</td>
</tr>
<tr>
<td>6 4 2 (-)</td>
<td>(-)</td>
<td>Any three numbers</td>
</tr>
</tbody>
</table>

The rule is “any three increasing numbers”. (correct)

The ideal test taker thought: “Based on the initial example, I would say that the rule is ‘three even numbers that increase by two’”. And then they asked themselves: “Does it matter that they increase by two?”. And after the first attempt they realized that, no, it did not matter. After the third attempt they checked if the numbers had to increase and they discovered that indeed they had to. Hence, they arrived at the solution. The ideal test taker put forth a plausible hypothesis each time, and then tried to prove it wrong. Note that all the necessary information for discovering the rule was already present in the first four answers of the first test example of Tirril Gatty. However, the student was concerned with his hypotheses and not with the solution to the problem. He focused on himself and was unable to decentralize or to extract the information with respect to what his goal should have been.

Creativity and quasi-creativity: lateral thinking

Perhaps you have heard about lateral thinking, a term coined by Edward De Bono, the English author of the best-seller of the same name. Lateral thinking deals with a special form of insight, one that helps us overcome “internal” constraints, namely those formed by the organization of our own knowledge. Making this distinction between different types of insight is important because up until now the difficulty of the problems examined thus far (i.e., those requiring restructuring) was found to be rooted in the elements present in the problems themselves. There are cases, however, in which these difficulties lie more in the mind of the subject, in their way of interpreting the problem, than in the problem itself. We can examine this mechanism thanks to some simple problem examples.

The problem of the months: One month in a year has 28 days. How many of the remaining 11 months have 30 days?

Think about it for a moment before reading any further.

Usually when we encounter a problem such as this we try to remember how many months have only 30 days. We might use a mnemonic device such as the following to help us: “Thirty days have November, April, June and September. All the rest have 31, except for February which has 28, and 29 in each leap year.” Thus we may think the answer is four: November, April, June and September. However the answer is much simpler and immediate: all eleven months have 30 days! The way the question is posed is what throws us off track. In common everyday language this expression triggers us to think that the problem has to do with the “total” number of days in a month. Be careful! The question is not “How many months are made up of 30 days?” but “How many months have 30 days?”.
• The problem of the ball: How can make a ball which you throw with all your force come back without hitting anything (a wall, net, fence, etc..)?

Again, take a moment to think about it before going on.
Here the mental pattern that sidetracks us is our knowledge that balls are usually bounced, whether on the ground, against a wall or the racket of an opponent, etc... It would make little sense to throw it upwards, in the direction of the sky. However this is the creative answer. Simple enough. But first we must overcome an obstacle before it comes to mind. We have to counteract the previous cognitive pattern.

• The problem of money: A antique coin dealer offers you a coin dated 35 B.C. Is it a scam or is it an authentic Roman coin?

Again, think about it for a moment before proceeding.

The antique coin dealer is naturally trying to deceive you. It would have been impossible for the coin to have been minted with a date that foretold of a future event or time, such as “35 years before (the birth of) Christ”.

These problems are, in a certain way, a kind of trick. They are based on a weaving or intrigue between the organization of knowledge and pragmatics. Linguistic and social conventions get violated and the problem is thus produced. At the moment in which we reach the solution, we do not undergo an authentic experience of Aha-Erlebnis (Eureka!). We do not get the impression of having truly solved a problem. We have uncovered a trick, a type of deceit, a conceptual slight of hand.

You are likely to remember the old joke told by Jerome Klapka Jerome (1859-1927), in the book Three Men in a Boat, which goes something like this: “Tom, who hasn’t got a watch, asks Dick, ‘Do you have the time?’. Dick replies, “Yes”.

Understanding this joke requires a sort of restructuring. However rather than resolving the problem, it dissolves it.

Jokes are often based on such devices. The final laugh signals understanding, as well as the dissolution of the hitch, or the crux, on which the joke rests. In a minimalist way witty jokes exploit what is called quasi-creativity. It is as if the restructuring, accompanied by laughter (or a smile), makes everything disappear with the wave of a magic wand. We can speak of quasi-insight and quasi-creativity in reference to a not very productive mechanism (at least in the Gestaltist sense). And yet in our private and professional lives it is often more effective and freeing to dissolve or dispel problems than to resolve them. Dissolving or them can prove to be a precondition for subsequent solutions.

Exercise: Can you recall any situations in which the solution to a problem lay in dispelling it or in not thinking about it any longer? Is it hard to stop thinking about something?

There have been numerous problems invented by psychologists in either complicated or simple versions. The aim is to analyze the differences, so as to isolate the sources from which mental difficulties in resolving complicated problems arise. It is a bit like with the joke by Jerome, where the ridiculous or absurd arises when we compare Dick’s response with an obvious response to the question, one which would entail giving the time (e.g. “Yes, it’s 4 o’clock.”) rather than with a simple “yes”.

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This tradition of study pertains to the analysis of what we call quasi-creativity. It deals with scenarios that require restructuring and that do not lead to solving exterior problems, but to dissolving internal mental cramps or obstacles. It is what the great Austrian philosopher, Ludwig Wittgenstein, in the first half of the last century, said about the problems of philosophy: they are in our minds, not in the world. They get resolved, and thus dissolved. They must disappear because there is nothing to change except ourselves. Our minds must change. This is where the term “quasi-creativity” comes from.

In order to study quasi-creativity psychologists often had to resort to stratagems that transformed an easy task into a difficult one, however similar. Some are indeed very clever. I will give just one example from the many which Mosconi and D’Urso explored.

Here is the problem, which in reality is a non-problem if presented clearly:

Three friends have just finished having a snack at a restaurant. Each pay $ 1.80, for a total of $ 5.40. Initially the bill they received was for a total of $ 6. Each friend paid $ 2, but then asked for a discount. The restaurant owner agreed and gave them back $ 1. The three friends gave the waiter 40 cents and divided up the remaining 60 cents, i.e., 20 cents a head. How did they distribute the money amongst themselves? Or in other words where did the initial $ 6 go?

The answer is simple: 5 dollars went for the bill, 40 cents for the waiter, and 60 cents were left over (20 cents each). However banal, the story may appear more difficult to resolve if presented in another version which confuses the ideas of the reader:

Three friends have just finished having a snack at a restaurant. The bill comes to $ 6. Each of them pays $ 2, but they then ask for a discount. The owner agrees and gives them back $ 1. From this they leave 40 cents to the waiter and divide up the remaining 60 cents, i.e., 20 cents a head. In short, each friend paid $ 1.80 which, multiplied by three, equals $ 5.40. And 40 cents went to the waiter. Which makes $ 5.80. Where did the other 20 cents go?

Note that the trick occurs in the last three lines where conclusions, which are not actually conclusions, are made. Readers have more difficulty solving the problem when it has been complicated by an “artifice”, trick, or ploy.

The problems which make up real tests for analyzing creativity concern cognitive procedures (not the complications introduced by psychologists). This is a crucial difference. The fact remains that by analyzing the difficulties of uncovering the trick, or artifice, can enlighten us as to how thinking processes work. In this case, for example, the difficulty lies in the fact that one version of the problem overloads the working memory space.

From these examples a beneficial lesson can be drawn for our everyday professional and personal lives. How often are problems actually pseudo-problems? How often does the solution to a problem require a clarification of the question? How often can the solution to a problem be reduced to the dissolution of the problem itself?

Quasi-creativity has something to teach us. In fact, it has a lot to teach us. We must continue asking ourselves whether this is a “real” problem or whether it is a problem of our minds? Doesn’t being creative imply that we have to change the way in which we see things?

To change the way in which we see things means, for a psychologist, changing the type of knowledge and the strategy with which one tackles a problem. Until now we have examined various types of knowledge. First of all we looked at knowledge which is related to an external problem, one that eventually gets restructured, as with all the examples studied by the Gestaltists. Then we examined the types of knowledge which stem from the different strategies used in information research and retrieval, as with the “2-4-6” number example. Lastly, we analyzed quasi-creativity, namely those cases where the knowledge we need to restructure can be found within our own minds: and here is where the obstacles are concealed,
not in the external world. Now we have to examine the cases in which the obstacles to creativity reside in the relationships established between our minds and the minds of others. We will call “empathy” the ability to be creative in the restructuring of these relationships.
4. Creativity as a social phenomenon and empathy

Collaboration and conflict: the psychology of associated minds

In 1864 Carlo Cattaneo, the Lombard theorist of federalism (1801-1869), published in the magazine “Il Politecnico” his important work entitled *Dell’antitesi come metodo di psicologia sociale*. Refusing the concept of innate ideas, Cattaneo wrote:

All of the highest proofs of science and of virtue take place in the agreements and disagreements found in the intimate relationships among humans […]. It still remains to be investigated what other ways, besides that of language, can the associated minds in families, in classes, in populations, in the human race, contribute to average intelligence, or oppose/thwart if[…] what characterizes a new idea is the fact that it is born from the clash of more than one mind […].

Cattaneo wanted to show that in the cases in which multiple minds are joined together, where they clash gallantly in comparison and discussion, the result is better than when a single mind tries to tackle the same problem. Cattaneo was an Enlightenment thinker. Today we know that this is true only if the people involved are focused on the solution to the problem, on a common objective. If on the other hand they are pressured from outside sources, if they feel they need to “demonstrate” something or to agree in order for the goal to be reached, then the so-called instance of group-think occurs, i.e., the thinking or pressure of a group. Recently the term group-think, which can also concern group decisions of a political nature, was brushed dusted off and reintroduced by the Anglo-Saxon press in an attempt at understanding how the present intervention in Iraq came to be decided upon, an issue with which almost all American political representatives, republicans and democrats alike, were initially in agreement, even those who today claim to disagree with this political intervention.

Here it should be pointed out that artistic and scientific creativity, at least in the customary understanding of these terms, is the product of the workings of a single mind. It is difficult to write a book, compose music, paint a picture, or gain scientific insight on something if there is more than one person involved. It is true that group discussion can be effective in offering hints or cues, in creating the conditions for a creative act to take place (brainstorming); all of which are optimal ingredients, however, a cake is baked by just one cook.

Nevertheless, in this book we hope to deal with both the subject of creativity, as well as that of innovation, by examining the similarities and differences that exist between them. There is a radical difference between the two concepts. Unlike creativity, innovation is, by definition,

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12 Trans. Knaebel
a social phenomenon similar to diffused creativity. It is the result of a sort of collective mind, formed not only by the minds of people but also by cognitive prostheses, or rather the interaction of a natural mind with artificial systems and technological instruments (cellular phones, computers, internet, data banks, codified routines, and so on). This also holds true for innovations in the art world, unlike the creativity of a single artist, as the scholar Howard S. Becker demonstrated in his book entitled *I mondi dell’arte*, through examining the practices and social contexts of contemporary art production.

- **Exercise:** Can you remember occasions when the decisions made by a group of friends or colleagues resulted in being good, or bad? In your opinion what do you think made the difference? In the first case were the people in the group focused on finding a common solution to the problem? Whereas in the second case did it happen that some in the group wanted to convince the others of their ideas?

Before arriving at innovation it is necessary to explore the relationship between creativity and social factors. Again the separation is not clear-cut. In Daniel Defoe’s novel *Robinson Crusoe* (1719), an exemplar of the modern hero, solitude is the guarantee for an autonomous construction of the ego: “There was my majesty the prince and lord of the whole island.” And yet the assertive achievement or success of an individual, built on conquest and hard work, is based in part on the knowledge and intelligence of the civilization from which he/she comes. On the contrary, let us look at the character portrayed in Italo Calvino’s novel *The Baron in the Trees*. Seemingly he too is alone. He lives entirely among the branches of trees. He must resolve new problems without the help of others, just as Robinson Crusoe. However his autonomy is continually interwoven with social life, or at least with the most progressive part of enlightened society.

If we use experimental tests which allow us to concretely measure the creativity of different people, these two prototypical conditions can be produced: on one hand that of Robinson Crusoe, on the other that of the Baron in the trees.

We can use a test like “2-4-6” without giving any help, in its traditional version, or we can introduce a source that bears social values. After the test has been taken we can say to the test taker: “We know that the majority (minority) of people who took this test scored as follows […]” and then to see if this information influences the subject’s performance. In this case the subject is always alone, but he/she is given information of a social nature. This directs the subject in various ways which are systematic rather than random. In this way the solution is made either easier or more difficult.

Research conducted with adults on the issues of creativity and the influence of social factors can be traced back to the school of Willem Doise. In Geneva Doise resumed the work of Jean Piaget, the Swiss pioneer of studies on the age of development, and based on developing the intuitions of Cattaneo. Doise and his collaborators demonstrated the significance of socio-cognitive conflict and of the importance of the presence of more than one point of view in cases of problem solving on behalf of children. The interweaving of collaboration and conflict is what feeds creativity, something similar to brainstorming. The difference lies in the fact that brainstorming is a technique used for bringing forth new ideas, for tackling, in an initial phase, poorly defined problems. In these experiments, however, the task is well defined, even if the ability to procure the necessary information for solving the problems also plays a part.

The task of the “2-4-6” test is not merely a cognitive-style litmus test or a way to measure the creativity of the individual taking it. It can also be used as a kind of brainstorming. You need only administer it in a classroom setting, preferably one made up of
corporate managers than of regular students, to see its effect. Usually company managers are more accustomed to the collaboration and exchange ideas. Once the test has begun, you will find that the scene becomes increasingly more animated. The most extraverted among the managers will usually present the first set of three numbers. They often have no trouble explaining to the class instructor (in the role of experimenter here) what their reasoning is for suggesting this set. Following this others will begin to explain their suggestions. At times the debate gets so intense that the participants forget the task at hand (solving the problem). When they do return to the problem, it is usually solved in no time. If this happens too soon, as it sometimes does in a group, it is tricky to demonstrate and explain the difficulty there is in arriving at a solution on one’s own. After insight has occurred the problem becomes futile if used again. It cannot be presented a second time because the solution is difficult to forget. Strictly speaking, from the perspective of psychologists interested in using the problem, the fewer people who know about it, the better the results. Fortunately, all that is needed is a slight variant with an equally logical structure for the problem to seem new. This speaks volumes for how our minds function.

Who will win the beauty contest? Creativity and empathy

We must take another step forward and complicate things just a bit more. What is the relationship between creativity and empathy? Empathy, as we know, is the capacity for being on the same wave length with others (i.e., on the same brain wave). It is not the same thing as sympathy. Sympathy is the sharing of pleasure (a sympathetic person is one with whom you get along well), which turns into compassion in the case of suffering. Empathy is a bit different. It is the ability to see inside the minds of other people with whom we interact in order to envisage how they might behave. What we then do with this information or reading, is a matter we will leave for another time: if we are fiendish we will manipulate, if we are good we will try to bestow pleasure. Nonetheless whether we mean to bestow unkindness or favours, and in order for either to take effect with the recipients, empathy is needed. What interests us here is that empathy is a condition for creativity.

In order to solve a problem in a brilliant way, when is it necessary to know how others represent the problem to themselves? Many day-to-day scenarios have these characteristics, for example all problems involving coordination. Imagine that you need to meet a friend but she is not aware that you are looking for her. You must predict your friend’s movements in order to find her. Where would she be? Where would she have gone? If you then wish to surprise her, say with a gift, you will have to find something that you think she would like to receive from you (not necessarily the gift she wants the most). In the workplace this is an ordinary situation that takes place everyday. What do we think the competition will do, and what do they think we would do? And what do we think they think of us? The individual who knows best how to decipher this sort of mirror-like game is the someone with the ability for seizing the most interesting opportunities in a competitive market.

- **Exercise:** How often are arguments caused by a lack of empathy rather than by an actual difference of opinion? Are you sure you know what others expect of you?

It was John Maynard Keynes (1883-1946), the great English economist, who first described in precise terms the mirror-like game described above by trying to explain the essence of previsions made in the financial world. In popular English newspapers of the 1930s there was a popular game which was slightly similar to that of a “Miss America” pageant. Newspaper X would present a very lavish spread of photographs depicting
candidates for the title of Miss X. If my memory does not fail me, I believe the winner of the “Miss America” pageant is chosen by a jury or by a selected group of television spectators: each makes a choice based on their own tastes and the candidate with the most votes wins. Whereas the winner of the Newspaper X pageant was chosen by readers who could predict which six contestants, out of a total of one hundred, would receive the most votes. Ever since then this problem has been cited in all manuals as the beauty contest, according to Keynesian terminology. Of what interest is this to us? It is interesting because as usual we make choices based on our tastes or preferences, revealing these through our behaviour (tastes as preferences, as we mentioned earlier). Whereas in the case of the English newspaper contest, insight consists of realizing that our personal tastes have no real bearing on the matter. We are obliged to predict the average tastes of others. If the other competitors also have some insight, that is if they understand the structure of the game, then the mirror-like game is triggered off. Whoever has insight does not choose according to his/her own tastes, but according to the tastes he/she thinks that the others think are the tastes of others. And so it goes on in a ricochet movement without end and triggered by empathy. In everyday life things are much simpler. For example, not all the readers of popular English newspapers had empathetic insight. In fact the majority of readers were healthily self-centered individuals who could not wait to express their personal tastes. Therefore they misunderstood the problem: they had not been asked to choose the contestants who they thought most beautiful, but to choose the contestants who they thought the majority of people, namely everyone else, would have considered to be the favourites of everyone else.

Keynes told a story concerning how the stock exchange functions. Let’s suppose that an investor buys some shares with long-term prospective. The investor should concentrate on the quality of what he buys (adopting what experts call “fundamental analysis”). If on the other hand the investor buys with short-term prospective in mind, he will not ask himself how good that particular company is, but rather how that share will perform in the stock market. Naturally he knows that the share’s performance depends on choices made by others. If the majority of investors believe that the others believe that the share is going to rise, they will act accordingly and buy. The result is that the share rises. It rises not because the majority of people believe that the share is “good” but because of a sort of self-fulfilling prophecy. A prophecy that is realized exactly because it is shared by many.

Here is evidence of the importance, in the world of finance, of rumors, secrets, gossip and tip-offs! There are essentially two kinds of investors and savers and the difference between them is similar to the difference found between the two types of beauty contests. “Long-term investors” (because they buy shares and then put them away in a safe deposit box) choose the candidate who in their opinion looks the best (as with the Miss America pageant). Speculators, or stock gamblers, choose the candidate who they believe the others think is the preferred candidate, and so on in the customary and never-ending mirror-like game (as with the English newspaper and the Keynesian beauty contests). Notice that this is a subtler game than those strategic ones. When you play chess you think, ‘If I do this, what will my opponent do? And then what will I be able to do? And then my opponent?’ etc… Here the analogy to the beauty contest concerns only the “depth”. Depth 0 consists of thinking only about your move: zero empathy. Depth 1 concerns contemplating the move of the other. Depth 2 is about concentrating on the move you are going to make following that of the other, and so forth. In the beauty contest it is not enough to merely run through the various depth levels concerning the moves of an opponent. It concerns a group and not a couple. You must also calculate an average value to predict how many components have gained insight (to understand the nature of the mirror-like game) and how many have not (and they will act in
accordance with their tastes, just like the judges of the Miss America pageant). It is a problem with a complex after all and is composed of the following steps:

1. understand the mirror-like structure;
2. try to estimate how many of the competitors have understood it;
3. evaluate the choices of those who have not grasped it;
4. try to understand how those who have gained insight will assess the choices of those who have not gained insight, and so on.

5. The structure of insight is so complex that an opponent may win by sheer chance in the end. Winning, however, is not important. Success does not necessarily have anything to do with creativity. Creativity consists in understanding the structure of the game more than in the ability to estimate the insight of participants.

Is it possible to translate this complicated cognitive and social structure into a simple task? A simple task such as that of the well-studied “2-4-6”? A problem has recently been invented with such features and one which I have tried out in the classroom more than once.

A tricky game

Here is a seemingly simple game but one which is actually quite tricky. Read how it works carefully and then, if you are able, try it out with a group of friends. It is a game played in company and for a small stake (let’s say 1 dollar). You should act as the experimenter and present the following instructions to the players: “Each player must choose a whole number between 1 and 100. The winner of the game is the person who comes closest to half of the average of the numbers chosen by all participants.” Simple enough. So what is the answer (solution)? Apparently there is no one single answer. And yet there is a winner!

The way people usually respond is like this: the first number that comes to mind is the number 50. Without knowing it, we tend to choose the number that lies midway between 1 and 100 (just to give you an idea, 80% of the 200 managers I tested in a series of sittings responded in this way). If everyone chose 50 and stopped there, then the exact answer would be 25 (half of the average number chosen by everyone). This means that no one has an once of insight and the stakes would have to be divided up amongst all the participants: everyone, or better no one, would win. This has never happened in a classroom of mine.

Individuals, even if they do not have true insight, figure that a problem posed by a professor in a classroom cannot be so simplistic. Therefore, there is always more than one student, at least among my company managers, who begins to show some doubt.

Here is the first step: “If everyone thought of the number 50, and thus chose 25 as the answer, then the exact answer would be 12.5 and I would chose that as my answer.” Immediately after this doubt usually sets in: “But if everyone else reasoned as I did then the answer should be 6.25… and so the exact answer would actually be ….”. Continuing on like this until we arrived at the smallest number possible in the series, i.e., nearly at 1. We move from doubt to a “creative” answer. Why is it creative? Because it was decentralized in the minds of others. This, in actual fact, is what empathy is.

Here insight consists in realizing that we will arrive at 1 no matter what the number we start with is. For the sake of argument let’s suppose our opponent starts with the highest number of an interval, in this case 100. Even if everyone has insight we would still arrive at the extreme opposite, that is, at nearly 1.
Flawless and crystalline rationality, present in our minds and in the minds of others, always coincides with the smallest number of the interval chosen for application (in our case that of 1, but which could have been a different number, such as 0 or another whole number greater than 1). The percentage used when presenting the problem does not necessarily have to be “50% (or half) of the numbers chosen by everyone”. I tried it with a percentage of 80 and the result was the same. Obviously it has to be less than 100%. The elegance of this problem comes from the fact that the numerical interval and the percentage of reduction can be changed: the solution with insight always coincides with the lowest number of/limit to the interval chosen (in our case, 1). This occurs if insight is shared by everyone, something which actually never happens.

- **Exercise:** Are there cases in which the **agreeableness** of something also depends on the tastes of others? If you go to see a show or a film with your friends, do you find that there are situations in which the **right** thing to do depends on what others do? Is there any difference between these two scenarios?

The problem does not end here. In fact the interesting part begins only now. When you do this exercise in a classroom there are two cases: either the people in the class know one another or they do not.

If they do not know one another then each will make their own appraisal by glancing around the room to see how many people have arrived at a conclusion or gained final insight and how many have not. Suppose a participant presumes that all the other people in the class, whom he does not know, arrive at a conclusion (he observes them come to their conclusion even though he does not know them). Hence, he will answer 1! If his prediction were exact (as I said before it never actually happens), then everyone would win. If instead the participant knows the other people in the class, and he writes down the number he has chosen together with his reasoning, then things become a bit more intricate (moreover if everyone is in the room). For example, I have presented this exercise to managers and executives of a well-known bank. Many of them confessed to having chosen the number 1 in order to show that they understood the structure of the game, even if they had also realized that not all of their colleagues would understand (and that therefore the number 1 could not be the exact answer). When this game is played in the classroom, in a corporate-university (as large corporate training centers are called today), the participants are obliged to comment on the results of the game at the end of the class. At this point the most extroverted members are inclined to explain to the others the reasons behind their choices. Social empathy manifests itself. You can do this exercise with a not too large group, say no more than five or six people, and where participants know one another well. When the group is made up of business managers or company executives it is usually easier: you need only direct yourself at a company work group. In order to explain their choice each group will try to predict how far, or how deep, their other colleagues can go. Joe will begin to explain his ideas regarding the choices made by others in a manner perhaps like this: “I know Bill is impulsive, a decision maker, therefore he’ll probably have stopped at the number 25…”; Instead Tom is quite reflective and analytical, so he’ll have stopped at 12.5…”, and so forth for each of the four or five participants in the game. Everyone will evaluate everyone else and in this way each participant will discover what his/her colleagues think of him/her. Usually the majority of the people who gained insight tends to overestimate the responses of others and assign them numbers which are lower than those they actually picked. The winners are usually the ones who are most suspicious. It is hard to go wrong by having overestimated the creativity of our colleagues.
Technology, talent, tolerance: where creative environments grow

Emotional intelligence tests were invented by large American multi-national firms specializing in consulting and training. The firms actually extracted information from responses given by people who had been interviewed. We know that this method is unsafe and feeble. Perhaps it is more interesting to ask ourselves which are the environments infused with creativity, the places in which new ideas are more apt to emerge. I think the most convincing answer is the one given by Richard Florida of Carnegie Mellon University in Pittsburgh. Florida states:

The key to understanding the new economic geography of creativity and its effects on economic outcomes lies in the 3T’s of economic development: Technology, Talent, and Tolerance. Each is a necessary but by itself insufficient condition: To attract creative people, generate innovation and stimulate economic growth, a place must have all three.13

I will not speak about the factors which make technological innovation concentrate in one place rather than another. However it is interesting to point out what attracts talent and tolerance. In the U.S. Richard Florida discovered that there are cultural events that are more effective than others in attracting persons of talent. It is not crucial to have expensive and important cultural centers such as symphonic orchestras, operas and ballets. There are none of these in Austin, Texas, the center for high-tech businesses. Instead a “minimalist” form of cultural activity is quite widespread in Austin and takes the form of a dynamic music scene and numerous outside attractions. The three “T”s explain why cities like Baltimore, St. Louis, and Pittsburgh show no signs of growth despite being cities rich in technology and universities. They simply are not sufficiently tolerant or open enough to attract and maintain the best creative talent. To be tolerant and open means seeing things from another’s point of view, decentralizing oneself, accepting diversity, encouraging the entrance of “variants”, and welcoming others. It is not by chance the Gay Index is an effective indicator, namely a way of measuring tolerance levels for different life styles. Again Richard Florida observes:

It is not because the high-tech industries are populated by an army of homosexuals or bohemians, but because artists, musicians, gay and creative people prefer places that have an open mentality […]. The predictive validity of the Gay Index does not depend on a gay predominance in the high-tech and technologically innovative industries, but merely represents a revealing indicator of mental openness and tolerance, important qualities for those working in the creative fields. 14

Our psychological analysis of the relationship existing between empathy and creativity fully corresponds to the sociological analysis made by Richard Florida. There is a close tie between the ability to see the world from the point of view of others and tolerance, critical thought, and the acceptance of diversity. Empathy is the most important component in social life. It is empathy which provokes diffused creativity, that which Florida calls creative environments. It is the bridge that unites artists and information technologies. This low common denominator explains why the appealing elements are the same for people who are all in some way creative but have different professions, and why these elements produce the high urban concentrations referred to by Richard Florida.

In Florida’s opinion creativity triggers technological innovation. But how does this triggering work? I use the term “trigger” because the creative act is not enough in this case. Technological innovation manifests itself in products or services that must be closely examined by the market and according to a Darwinian-type filter. Indeed, in the market, there appear variants of the same industry competing among themselves. These variants are not spontaneous as with biological variants. Rather they are products invented and marketed by firms. Take for example the computer. Some models and brands have become popular and well-known, while others have more or less disappeared gradually. Creating the conditions for innovation is equivalent to creating as many variants as possible.

In order to understand how innovation works and why it is different from creativity, let’s begin with a classical corporate case which reproduces those cases created and tested by the Gestaltists.

In an attempt to find a chemical formula for improving the resistance and effectiveness of a certain glue product, the research labs of 3M - an American multinational - came up with a formula which initially seemed unsuccessful. A good glue should bind two or more pieces together with a considerable amount of strength and for a long period of time. However the 3M product never seemed to harden and always remained sticky. As legend has it, one of the firm’s secretaries came to hear about this pseudo-glue and started using it for sticking small slips of paper, in the form of memo notes, to smooth surfaces around her work station. Other secretaries began to do the same and soon a new use was established for this “unsuccessful” glue. It was an unsuccessful glue only from the point of view of traditional adhesives. Once these traditional canons were left behind, it was possible to see that a new product had been discovered: the Post-it. The Post-It is used for purposes no one had thought of before. Paraphrasing Oscar Wilde: Genius is not in knowing the answers, but in posing the right questions. The secretary at 3M saw a new “potential” demand for adhesives. In a certain sense she was the one who created the Post-it, not the person who had originally proposed the unsuccessful glue. In other words, it did not involve solving a given problem in a creative way. The creative aspect was the invention of a new use or application of the product: this is the essence of technological innovation!

The actual processes of corporate innovation are often times more tortuous than the textbook example of the Post-it, a quasi laboratory case, an insight into a new need. In order to analyze the more complex forms of industrial innovation we must follow a thread consisting of all the mechanisms which have existed up until now. Innovation generated within a company or firm usually gets diffused. Creativity settles, remaining ready to be revived when needed. We will then speak of *diffused creativity*. The typically Italian phenomenon of industries is interesting because it shows that the boundaries of firms are not impermeable, but rather “porous”. Industries act as diffused creativity tanks. Some knowledge filters through and settles, creating a seat which is shared by the innovative technological culture. We will look at this further in the following chapter.
5. Creativity and technological innovation

Trademarks and patents

While creativity is intertwined with the history of human civilization, technological innovation is the recent result of the industrial revolutions. There are two main signs of innovation: patents and trademarks. Patents record innovations in productive processes or in products themselves. Trademarks categorize and fix an abstract type of innovation. If we wish to create a personalized promise of wellness for a product, emphasizing also its source, then we need a trademark. A trademark is nothing more than the name of the company or persons making this promise. The more the name is known, the greater the responsibility of a promise is in terms of credibility and reliability. Therefore, a trademark does not only classify a product or a class of products but represents a guarantee for well being, satisfaction, and emotions. Innovation through trademarks is a very recent phenomenon. More trademarks have been created in my lifetime than in the whole history of mankind. Whereas patents go hand in hand with the great technological revolutions triggered and fueled by a society based on mass consumption.

Throughout the history of technological innovation we have experienced two great technological revolutions with general social aims, that is, they are not restricted to specific productive industries. They are called GPT (General Purpose Technology) by scholars. GPTs pervade every aspect of our lives, from the home to the workplace.

The first of these two great revolutions was electrification, which began with the construction of a hydro-electric plant at Niagara Falls, U.S. in 1894. Although still in full development today, the birth of the second GPT, that of innovation in the field of information technologies (IT), conventionally dates back to 1971, the year in which the INTEL 4004 chip was first introduced.

Let’s take a look at figure 14. The chart shows the number of patents and trademarks that have been registered in the U.S. since 1790 with relation to population figures and to the two great technological revolutions cited above. Electrification and information technologies are similar in that they both helped the invention and personalization of new manufacturing processes and products. The grey areas of the chart indicate the periods when innovation spread into firms and homes. In the case of electrification, which required the construction of a complex infrastructure network, the process leveled out near the end of the 1920s, when diffusion was complete. In the case of information technologies, we are still in the stages of full development.

- **Exercise:** Take a good look around you. How many objects in your house have a trademark that you recognize? Is this trademark the name of a person or the company that manufactures it? Is it a name of an invention or does it merely serve to differentiate that product from other products on the market?
By observing such a ratio as “number of patents-trademarks per every million individuals”, the immaterial character of this era of innovation is evident. It is evident both in the obvious sense, namely that the crucial thing about computer networks is the processing and transmission of data, or software, and not the computing machines themselves (hardware), and also due to the emphasis being placed on developing immaterial aspects such as communication. A number of trademarks which would have been inconceivable in the past have been created and are still being created today. The only limiting aspect to this has to do with the memory of individuals, although this is improving today via communication forms like advertising, and via other powerful external prostheses such as computers and networks.

By using a GPT, now widespread in every home and office, we are given a unique opportunity to create inventions. However, a complex network exists the three Bs (Bath, Bus, Bed) we cited earlier and the three Ts (Technology, Talent, Tolerance) of Richard Florida. Individual creativity and diffused innovation strengthen each other. Over the last two decades this network has become explosive. Innovation has disengaged itself from material matter and become pure communication. It is not necessary to invent new “substantial” functional features. It is enough to develop new “life forms”, new needs. Form does not follow function as it was said to do in the past.

Technology and design as diffused creativity

In recent years my colleagues Micelli, Bettiol, Finotto and I have often visited the clothing and sport shoe manufacturing districts of Montebelluna, a town in north-eastern Italy, and its surrounding area. In these districts creativity is often spoken of as a source of constant innovation. The appearance and quality of the product is rooted in a long-standing tradition of craftsmanship. As we can see in the excerpt below, taken from an interview with Silvano Lattanzi and Emanuele Sarci in the Italian newspaper Sole 24 Ore (September 8, 2004), there is a common notion shared in the shoe industry:

Creativity and know-how are the only things that the competition will never be able to clone… the difference between a strip of leather and a shoe is in the hands of the craftsman making it. These craftsmen are the hardened and indefatigable protagonists of extreme luxury. They are the ones who cut, glue, stretch, sew, nail, tinge, shine, and caress the material. It is the sensitivity of their fingers that give the added value to those masterworks which adorn the feet of famous people, from George Bush to Bill Clinton, from Queen Elizabeth to the Crown Prince of Japan, from Sylvester Stallone to Riccardo Muti, from Francesco Cossiga to Arnold Schwarzenegger.15

When I look at or touch a ski boot it usually seems “heavy” to me although I see it “as elegant”. The first act is a sensation, whereas the second act concerns perception. The first is unalterable. The second is a mental construction triggered by the culture in which I live. The theoretical key to analyzing the processes of design innovation is found precisely in this “way of seeing”. It is recreated every time a person has that aesthetical experience, on the condition that they do not change their tastes or preferences, as we observed in the first chapter of this book.

I can limit myself to talking about the history of the shoe manufacturing district of Montebelluna in purely economic terms. I can disregard all that is mental and all diffused creativity. It will suffice to measure and list the indicators related to manufacturing, district organization, retail and product distribution, and consumer reports on each particular product. This is the approach used by marketing researchers when measuring the industrial effects of

15 Trans. Knaeble
innovation. And yet the processes of invention, those which triggered these effects, reside precisely in the ability to create that “way of seeing”.

The real processes of innovation concern those manufacturing methods which give a competitive advantage to the functional features of the products. Take for example the use of plastic instead of leather in making boots. The change or substitution in materials occurred thanks to a perfect case of creativity, ignited by social interaction. This would have pleased Carlo Cattaneo, the first to have spoken about psychology of associated minds.

The introduction of the pvc or plastic injected sole into old hiking boots is a case I want to mention mainly because it encapsulates all the components we have examined up to now. Until 1965 shoe manufacturing was an entirely handcrafted affair. Older readers, and particularly those familiar with the history of the Italian shoe industry, may remember the “Vibram” shoe sole, or a similar product. The Vibram sole was cut and shaped according to the size of the shoe and then glued or sewn onto the upper. Plastic was considered a cheap and shabbier material compared to that of leather, thought of as traditional and “noble” (Gianni Munari tried to introduce a sort of thermo-plasticized leather which would make the boots completely waterproof. However, the attempt was unsuccessful for several reasons, including that of high costs). Plastic was a material well-suited for certain household objects like cooking utensils, although it did not seem fit for loftier articles such as clothing. The trick was in repositioning the object and in creating a new product category: boots are not “big shoes” but something different (even today normal walking shoes made from plastic seem slightly repulsive to us).

Surmounting this “cognitive pattern” took place thanks to the interaction and combination of three different types of expertise within the industry. It resulted in a new way of making shoe soles. Sergio Brunetti was an owner of a firm in Mussoleonte, a small town near Vicenza, who had started off working with plastics for building materials (for example rolling shutters) and insulating components. Virgilio Lorenzin was the owner of a factory in Padua specialized in machinery for shoe manufacturers (an industry which was undergoing a major crisis at the time in the soling machine market). Primo Zizola was the technical consultant for all the main shoe manufacturing companies in the Montebelluna area (Dolomite, Nordica, Tecnica, San Giorgio). All three men knew one other and were good friends. Brunetti identified the perfect material to inject directly into the upper (granulated pvc plastics), which resulted in a product of higher quality and significant savings in manufacturing costs. The invention was then applied to ski boots with the result of greater torsion rigidity which provided greater performance and a flatter sole which was safer and better suited for attaching skis. A cognitive constraint was broken: why not make the entire boot out of plastic? It would be easier to produce, more water resistant, sturdier, and allow for the ski to have greater control with respect to traditional ski boots made in leather. The threesome continued their collaboration. They convinced the German firm Bayer (the producers of aspirin) to supply a more suitable material: thermoplastic polyurethane. They built up and then later bought out the GBF plasticization company, located in Bresso (near Milan) and producers of injection presses for molding plastics.

While visiting an American trade fair, the company’s financier, Aldo Vaccari (from the firm Nordica), noticed a prototype of a potential competitor, Bob Lange. The following year the Italian group presented a technical solution at the same trade fair which turned out to be superior to the product offered by Lange despite the latter having had a year’s interval to refine and improve it. Lange’s technique was based on a procedure of casting within the moulds themselves and required a thicker layer of material. The outcome was that the boots were heavier and the reject material increased by 30% (compared to 2% with the machine by Lorenzin). In addition, by using Lange’s technique it was necessary to resort to manual
operations for joining the two half-shells forming the boot. Instead the Italian boot was composed of one single piece, molded in a single operation by the use of the techniques mentioned above. It resulted in the ski boot we know and admire today. Lange acknowledged the superiority of the Nordica products headed by Vaccar, and after moving to Italy he adopted this more advanced technology of his competitor.

This case is a good example of social creativity in two way: firstly, the culturally shared beliefs that leather was a superior material to plastic were abated; secondly, in order to reach a shared objective (one which had first been posed by Bob Lange), it took the social interaction of only three different areas of expertise. Moreover, this example shows how technology is almost always something more than just scientific discovery even if the precise division between the two is not necessarily evident. It is not enough to simply have an idea, like in the case of Bob Lange. A gradual process of trial and error is also required and one interwoven with moments of micro-insight. What is crucial is the tiring work of that mental collective, formed by various participants with different expertise backgrounds but who are working for a common goal. Our of this is bred innovation, the technological improvement, a new product which changes the lifestyle of millions of people, including those who benefit from it, and those who provide for it.

Innovation within the firm, the outside clone

Let’s start by asking ourselves why a firm is of a certain dimension or size: why has it not expanded and decided to internally produce products and services acquired externally? Why has it not sized-down, shifting internal functions to outside sources? From the point of view of innovation, the answer, although a bit simplistic, is that a firm either purchases, or has produced from outside sources, products which can be cloned. This is due to the fact that these products are available to everyone. On the other hand a firm often maintains within the company those products or ideas it believes to have invented and there is somewhat jealous of. In a nutshell, a company’s capital resides in its ability to be innovative - a process that distinguishes its competitors. This is where that portion of “image” capital, in the form of the company or product’s trademark, comes into play. The trademark is both a guarantee for and a promise of creativity.

From a linguistic point of view, trademarks are the only case in which it is possible for a proper name to become a well-known common name (at least while individuals remain unclonable). Take for example the Frigidaire refrigerator or the Hoover or Vacuum cleaner. When pop artists began producing serial pictures (e.g., the images of Marylin Monroe by Andy Warhol) they mimicked the German critic Walter Benjamin, the first to speak about the reproducibility of art works and trademarks. For example, they produced pictures composed of Coca-Cola cans: a proper name which became common when millions of identical copies are reproduced. For today’s designers, establishing a true trademark means projecting their own identities as creators to the outside world. Here is another extract from the interview with Lattanzi:

“At that time I was involved with the political left,” Lattanzi remembers, “and a dear friend of mine, Silvano Sollini, kept telling me that I represented a contradiction in terms because of my wish to be also be an entrepreneur. When I was creating my logo I acted accordingly: I anagrammatized my surname but took out a “t” (from “Lattanzi” to “Zintala”). Bent on a fixed idea: the exasperated search for perfection in the multiple original.”16

16 Trans. Knaeble
By hearing the accounts of successful shoe industry entrepreneurs like that of Silvano Lattanzi (as well as many others like him), we are tempted to downsize the problem of innovation. When the work of a single entrepreneur reaches a significant level, we risk making the crucial mistake of disregarding the issue of innovation of mimicking psychologist and economist Herbert Simon who said: “Creativity is entirely inside the mind of the individual”. We accept this hypothetical postulate, even if groundless. We find ourselves faced with a mystery: why some firms able to invent new solutions in the face of unforeseen creative problems and others are not. In order to respond to this we must think of think of the firm as not so much as a meeting place, or a place of interaction among individual minds, but as a collective system of knowledge. In the words of Ikujiro Nonaka and Hirotaka Takeuchi: “[…] organizations are communities in which knowledge is transferred in the production of goods and services.”

The problem which the scholar specializing in corporate creativity faces is similar to the one faced by the scientist studying the products of the evolution of species. Let’s observe, for example, a part of the human body such as the eye. The eye is a perfect instrument. We cannot retrace all of natural history except only in an ideal manner. Yet the eye is nothing more than a marvelous outcome of this evolution driven by circumstance and chance. In short, we have to commit ourselves to what Steven Pinker, Director of the Cognitive Neuroscience Center at MIT in Boston, called reverse engineering while making reference to Darwin:

The rationale for reverse-engineering living things comes, of course, from Charles Darwin. He showed how "organs of extreme perfection and complication, which justly excite our admiration" arise not from God's foresight but from the evolution of replicators over immense spans of time. As replicators replicate, random copying errors sometimes crop up, and those that happen to enhance the survival and reproduction rate of the replicator tend to accumulate over the generations. […] Darwin insisted that his theory explained not just the complexity of an animal's body but the complexity of its mind.17

The same mechanism of deconstruction can be applied to the technological evolution. Fortunately, in the simplest cases like that of the invention of the ski boot, this is the result of a few mere decades, and not millions of years, thus making it possible to interview the main participants involved. If we are speaking of the biological evolution, it is obvious that there are no protagonists to interview. However we now have the ability to simulate this thousands-of-years-old process. In this way a model can be constructed which reports not only the results of this process but also how such results were obtained.

In the neighborhood of Venice where I reside, there also lives a famous ethologist by the name of Danilo Mainardi. Mainardi once told me about a colony of geckos which had found their ecological niche in our neighborhood. Indeed a family of geckos has now made their home, much to my wife’s delight, on my terrace. Kellar Autumn, a scientist from Portland Oregon, together with some of his colleagues from California, uncovered the mystery of the gecko’s amazing ability to climb upwards while keeping its head pointed downwards. A phenomenon which Aristotle also observed in his *Historia Animalium*. Geckos do not hold on to surfaces by their fingers, nor do they use a sticky fluid like that of the post-it. Instead they make use of the forces of Van der Waals, thanks to millions of extremely thin, microscopic hairs (200 billionth of a meter in width). In order to remain extremely close to a surface without ever actually touching it, geckos activate a sort of force, or pull, which exists between the molecules located at the end of their bodies and the molecules in the materials over which they brush. In this way a gecko is able to climb just about anywhere without ever dirtying

Kellar Autumn and his colleagues used a mathematical model to simulate the size and width of the gecko’s hair particles, as well as the force that this “remote glue” holds. It was found that the skin of a gecko can support up to nearly two hundred kilograms!

In this way we can model the results of creativity of the biological evolution, which by nature is a random process although in laboratories it can be simulated through tracking conditions over the course of several thousands of years. Nobel Prize winner Herbert Simon, who we have mentioned earlier, reproduced in computer form some of the most important scientific in history. However, as Johnson-Laird and I have both pointed out: constructing the model of a discovery is one thing, simulating the course which led up to that discovery is quite another.

Unlike biological and cultural processes, the paths leading up to technological innovation cannot always be imitated unfortunately. In fact they are often times so complex that they show no trace nor sign of contributions made by the often times numerous and widely dispersed creators.

Thomas P. Hughes (1998), the great American historian and sociologist, explained the complex succession of events those projects which most significantly affected the second half of the 20th century: namely that of Atlas and Arpanet (the latter refers to what we know today as the Internet, originally constructed by the U.S. armed forces). It is interesting to note how the majority of us have no idea what these names refer to. Atlas, for example, consisted of a collective enterprise that led to the construction of the first intercontinental missiles on behalf of the U.S. government, with considerable effects on the aerospace industry and the Cold War. It is evidently difficult to give credit for such a project to one individual alone. The Atlas project involved over than 18,000 scientists and engineers from different universities and military outfits, nearly 70,000 technicians, workers, and employees from over 22 industries, 17 contractor firms, 200 subcontractor firms, and at least 500 officers in the armed forces. Each and every participant was assigned a precise task but were not furnished with any picture of the overall project or complete system. This is a great example of distributive knowledge! History is not easily retraced, as Hughes himself admitted, because of it being buried in thousands of layers and rivulets. Let’s try, for example, to re-read the statement made in 1945 by Vannevar Bush, Technology Advisor to the United States President, as well as Director of the Office of Scientific Research during the Second World War:

There has been a great deal of talk about a missile which is capable of covering a distance of over three thousand miles. In my opinion this is impossible and will remain impossible for many years to come. The people who wrote such things allude to a rocket which capable of carrying an atomic bomb from one continent to another. A rocket with enough precision to be able to hit a target such as a city. I believe that technically no one in the world knows how to make such a weapon as this and I am certain that it will not be accomplished for a long, long time. 18

Contrary to Vannevar Bush’s statement, a missile to the likes of that described above was realized just a few years later. This project, like many of the other projects Hughes mentioned, is the “promethean” result of complex and articulated organizations. Such a long standing (thousands of years) and pre-technological tradition as this makes it almost inevitable to associate the origin of creative acts with certain single individuals. In the case of Atlas, the principal protagonist was the great American-Hungarian scientist and inventor of computer architecture, John von Neumann (1903-1957). In actual fact, every single collaborator, including Neumann himself was unaware of the project’s overall picture. Not even those in charge had an comprehensive and complete “flowchart” of the project upon beginning!

18 Trans. Knaeble
These complex projects generated technical innovations which did not respond to previously established expectations and needs. The temptation of identifying a creator is specially strong when the thing faced with excites beauty, delight, or pleasure, such as with the shoes of Silvano Lattanzi, or the films of Francois Truffaut. Our immediate instinct or desire is to identify the author of such works. If this is not possible, as in the case of many industrial products and services, the invention of a “trademark” takes the place of natural authorship. Thus, it is easy to note how in recent times the number of trademarks has surpassed that of patents. Once consumers have been reached, technological complexity requires a degree of simplification obtainable only through the creation of a trademark. Only after a name has been introduced can we forget the individuals or firms associated with producing the related technological innovations.

An increasingly complex technological society such ours spreads creativity, guiding it through various communication networks. At the same time we are also compelled to simplify the communication of innovative processes by continuing to introduce more and more trademarks. This forced forgetfulness of who the real authors are, is imposed by the need to communicate, as simply as possible and to new potential users, the benefits of innovation. The betrayal is, as it were, two-fold: the creator is betrayed by being distanced from his/her innovation, whereas the complexity and richness of the collective process is betrayed by being artificially condensed into a single, immaterial entity – the trademark.

Innovation and tacit knowledge

The notion of a business as a repository of knowledge helps to explain its effectiveness by considering it as a means of conserving the innovation processes. What advantage would there be in belonging to a company if every employee had to learn all the information that the other employees knew? The concept of a company as a self-governing repository of knowledge is the basis for what are generally labeled as economies in transaction costs. The business serves to introduce coordination mechanisms, allowing for the different knowledge held by single individuals to be integrated into a sort of “collective mind”, otherwise known as a business. In turn these “collective minds” settle into “diffused creativity” which makes up the core of an industry district.

The study of the companies and businesses has lead to the definition of four main mechanisms which aid the integration of knowledge:

1) rules, policies, procedures
2) hierarchical and organized task sequences
3) organizational routines
4) combined solutions to problems on the part of more than one agent

These are also the same elements found in the cognitive sciences.

The study of innovation processes constitutes a breeding ground for the comparison of arguments made by economists and cognitive scientists. The process of product invention is not based strictly on “internal know-how” - namely the information a company collects on the market, its consumers and competition, as the analysis of the Montebelluna district well proves. For example in shoe and ski boot design, the spread of knowledge emerges when we notice that the design for new products is the result of interaction among several actors or participants from both inside as well as outside the firm. Participants usually vary in their professional backgrounds, competences and field knowledge. The company therefore is seen
to have a permeable border with the outside, insomuch as pertains to product design and invention but not pertaining to other areas such as the financial.

The first economist to have systematically dealt with the problem of codification of knowledge was Friedrich August von Hayek (1889-1992). In a conference held in Princeton on 20 May, 1946, as well as in an article published the preceding year, von Hayek insisted on the fact that the knowledge on which market order is based is scattered amongst a multitude of individual minds. This knowledge is therefore very hard to codify. It is forced to remain implicit not only because it is fragmented and difficult to construct or access, but also because it is tacit and, hence not clear even to those using it. We are mainly speaking of knowledge which manifests itself in routines, patterns of actio and coordination, and according to the taxonomy cited above. However, if we move into such fields as “new product development”, the methods for creating knowledge can be represented much better through the notion of mental models.

*Mental models and innovation*

The key for describing the transition from the tacit to the explicit in technological innovation, is found in the idea of the “mental model”. It concerns a simplified form of representation which can be increasingly enhanced until it takes on a definite, explicit form, otherwise known as the development of a new product. This process of enhancement allows for the growth and definition of insight, in the form of a project gradually shared and increasingly specified.

In the cases of businesses and firms we must be content with interpreting this progressive enhancement and definition of the initial model through the reconstruction of its genesis and history. It concerns telling case histories, at times epic, of the great natural experiments which took place in businesses and firms. Be aware, however, that a systematic distortion in reconstructing the events leading up to innovation is often due to the fact that in the company’s collective memory, only the successful cases (and trademarks) tend to be remembered, often times in legendary and ideal form. In the Italian newspaper *Il Sole 24 Ore* there have been stories published about Silvano Lattanzi, as well as about other people who knew how to seize and make the best of failed experiences. However, there exist no reports regarding people who have been excluded or removed from the market.

Let’s consider an example of worldwide success: the project of the *Honda City* car. In this case the initial intuition, or insight, can be traced to the creativity of a single individual, that of Hiro Watanabe. The process was based on a metaphor for a car like that of the *Tall Boy*. The model, vague and naïve at first, progressively grew into a shared project. It began with a visual metaphor, the image of a sphere which was to represent a car that was “short” in length, but “tall” in height. This mental model was then slowly shaped according to a specific functional intuition: “maximize the human element by minimizing the mechanical one”. The final project was the development of a design that had succeeded to translate a visual mental model into a functional expression of a car. This, in its entirety, specifies the need for the concept “more human/less machine”. The inherent creativity in this mental model follows from having done away with the constraints of the previous and dominant ideas regarding car design, namely that it should be “long and low-riding”.

The following operations were used in the process of improving and clarifying the initial model:
- ease up the constraints present in the (very successful) model of the *Honda Civic*. This was done by comparing the old, well-known and defined model with the new, vague and imprecise one;
- execute this “easing up” process through team work by creating a context of interaction among participants. The task of this mutual confrontation aimed at developing the implicit mental models (Do you remember empathy?).
- foster the creation of “abundant” knowledge on behalf of group participants, by starting with a “metaphoric” and “ambiguous” initial model, with the scope of facilitating the analysis of the project from more than one point of view.

Beginning with the success story that led to the creation of the Honda City, and from other like stories found in new product development, it is possible to define product innovation as a creative mechanism that originates from vague and implicit models. Such models are then enhanced and detailed through team work.

If we turn our attention from individual creativity to company creativity, we notice how standard types of knowledge organization can basically be structured in three formats:

1. “knowing what” (or “knowing who”): the facts, or a company’s data, such as market shares or client names;
2. “knowing why”: knowing the reasons for something, for example why consumer tastes change;
3. “knowing how” (or “know-how”): knowing how to do something, such as responding to changes in taste and style in an innovative manner.

It is in this last area of knowledge that the attempts to codify, and therefore the transmission of “know how”, fail and cause a lot of crucial information to be lost.

One can certainly write manuals that include some basic rules on how to play tennis or make love, but it is impossible to clearly express the expertise of Swiss champion Martina Hingis or the world-renown seducer Casanova. In such cases what is codifiable is barely recognizable and the “transfer” of knowledge requires a great deal of interactive learning (to say that it would be possible to codify this knowledge but for the cost being too high, is pure mystification).

In this case the “know-how” which Casanova and Hingis possessed, was what directed or guided their actions, even if the subjects were unaware. This knowledge is difficult to codify in a systematic way. It is therefore transferable to others only through a “story”, namely recording (a visual one in the case of Hingis) conducted under natural conditions.

Thus, it is understandable how in company training centers and *business schools* the problem of creativity within the firm is most usually transmitted through the analysis of successful case stories. This teaching methodology has the advantage of being simple and immediate, but also rather tricky. On the one hand it is not set within a general theory and therefore every act of insight, every process of innovation, is observed separately and by itself, making a comparison with similar cases difficult. Moreover tendency is to prefer the successful cases to the unsuccessful ones, resulting in a unrealistic and optimistic picture of company life and of innovation’s technological course. Finally, and on an even more serious note, is the tendency to assume that the presentation of case stories is educationally effective, in the sense that we assume such knowledge can be transferred to new case stories.

Actually, the only effective educational approach to these matters consists first in analyzing the individual cases and then in proceeding with an analysis of the general picture. Upon using this approach, we would then be able to tackle new cases and apply the proper
techniques. This way of proceeding does not consist in case comparisons but in the use of analogy. The correct way to proceed is to first analyze the individual cases, then construct a general picture to be subsequently used, by way of analogy, in dealing with new cases. We will examine this general picture or scheme in the next and final chapter.
6. The overall picture

The creative process according to Johnson-Laird

In the preceding chapters we examined the two main types of processes which lead to innovation:

- gradual progressive processes that involve trial and error;
- insight, namely an immediate restructuring of elements or the vision of new elements.

In common, everyday use the term “creativity” usually applies to the second case only. However, in this book I have tried to demonstrate how technological innovations, above all if they undergone gradual refinement, are the sometimes surprising result of an anonymous and diffused selective process.

Following is a list of the different types of knowledge which are developed through the adoption of one of the two processes, or a combination of the two:

- representations of the external world, in short: EW
- strategies for obtaining information, in short: OI
- relationship between the minds of others and our own minds, in short: OMO
- non-codifiable, tacit knowledge, in short: NCK

Examples of EW can be found in all of the problems studied by the Gestaltists and a few of which I have mentioned in this book. While OI types of knowledge refer to mechanisms of focalization and information collecting strategies (as with the case of the “2-4-6” problem). The classic paradigm of OMO is based on those types of exercises such as the beauty contest observed in chapter four. Lastly, tacit knowledge, as mentioned previously, constitutes the trigger and keystone of company creativity. This latter element develops from vague models which are defined and targeted gradually (remember the case of the “Honda City” car?).

In order to produce a general recipe, one needs to begin with the four ingredients described above (i.e., the different types of knowledge) and then see how well they combine and mix.

These four types of knowledge get developed thanks to what we call processes. The processes are positioned on a continuum which has one end the Darwinian-like procedure of trial and error, and on the other the procedure of insight.

Having made these distinctions, we can now examine the theory of creativity recently proposed by Philip Johnson-Laird, Stuart Professor of Psychology at the Princeton University in the U.S.

His theory, whose nature should be clear to us by this point, makes use of the following principles:

1. novelty/new idea: the outcome of a creative process consists of a “new” piece of knowledge for the participant;
2. non-determinism: the result of a creative process is non-deterministic, in the sense that it is not ascribable to a procedure-based calculation, as in performing an arithmetic problem;
3. constraints: the creative process is characterized by certain pre-set constraints and must fulfill certain obligations;
4. previous elements: you cannot create something out of nothing. Elements or components must exist in order to trigger and feed the creative process.

Johnson-Laird identified three cognitive architectures. With “cognitive architectures” he means the individual and collective mechanisms which make the processes of discovery possible. These structures would not exist if over the course of the evolutionary process our brains had been constructed differently. In other words, creative processes are made possible because of the cognitive architectures generating and guiding them.

The first two structures, schematized below, generate Darwinian processes - through trial and error - and Lamarckian processes which we will examine shortly. The third cognitive structure is a multi-stage process that unites the first two processes.

1) Darwinian Process

```
   Generate          Evaluate

   Casual variation               Constraints act as filters
```

2) Lamarckian Process

```
   Generate            Choose

   Constraints govern the process
                                 Chosen from among the possible alternatives
```

3) Multi-stage Process

```
   Generate               Evaluate

   constraints govern the process but only in part
                                 Other constraints act as filters
```

Let’s take a closer look at the mechanisms which make up the different types of knowledge. The Darwinian strategy works analogously to the mechanisms of the evolution of species, according to the Neo-Darwinian synthesis of genetics and natural selection. The spontaneous variants, which are generated by chance, are selected by the environment. The
environment then filters the best solutions thanks to a selection mechanism based on trial and error. This strategy is articulated in two stages: the first is a generative process where ideas are formed on the basis of implicit and tacit mental models. Following this there is a gradual passage into an evaluation stage in which constraints function as a type of filter. In this stage the constraints eliminate certain possibilities while making others evident and explicit. The surviving elements continue to undergo a selection process which discards alternatives until a final result is reached, as if in a sort of spiral motion.

As Carlo Cattaneo surmised, the Darwinian strategy is characterized by the fact that when the creative and innovative processes are shared among many actors, they occur much faster and more productively. Collaboration facilitates processes of invention and ensuing selection. This strategy, as it is easy to see, is the typical strategy used by the “Made in Italy” manufacturing industries. The structure of the value chain which exists among businesses specialized in precise phases of the manufacturing process, allows individual specialists to innovate a single, individual phase of the process while remaining in synergy with the other phases. In this way the entire sector acquires a depository of innovations ready for commercialization at the first opportune occasion. For example, in the district of Montebelluna, producers specialized in materials continuously produce new solutions the nourish the supply of new products. Although these new products are selected from within the companies, it is the market which has the final say. In many cases the innovative process found in the Made in Italy manufacturing districts maintain the following emerging characteristic: the lack of a detailed analysis of the opportunities, risks, and demand trends geared at effectively addressing new product development. In other words, innovation responds to a Darwinian-like structure of change, where the market acts both as a final filter and as input for provoking new ideas.

The Lamarckian strategy is different from the Darwinian one mainly in that the constraints governing the process are positioned bottom up rather than top down. Whereas the Darwinian strategy generates a large amount of waste which eventually gets eliminated in successive phases, the Lamarckian strategy is not as efficient: every type of possible restriction gets applied from the generative stage onwards. For this reason the Lamarckian strategy is often preferred for dealing with closed and well-defined problems. In a certain way the essence of creativity eludes this strategy (i.e., creativity intended as something which emerges unexpectedly and which until then was completely unknown). However, the Lamarckian strategy is able to produce good results, and quickly, when the constraints are clear and well-defined. For example, the standard methods used for developing new products within companies, i.e., customary marketing techniques, indeed adopt a Lamarckian strategy. Think of the various market tests used for “creating” new products and innovating older ones (e.g., the concept-use test, hall-test, etc…). These involve well-established techniques for introducing new “goods” and/or “services”, while keeping in mind market constraints already underway. Although this might appear to be the more rational strategy of the two, in the sense that it avoids waste, unfortunately, it is actually the less creative one. At the same time it is the strategy most often used in traditional marketing methods for “renewing” or “reinventing”, at least superficially, products.

Innovation in companies and the multi-stage process

In company environments the articulation of cognitive architectures which make creative processes and innovation possible, give rise to rich and complex networks involving more than one participant. This explains why it is the multi-stage strategy, the one based on a
combination and alternation of the two previously mentioned strategies, which normally describes the processes fueling innovation. Innovation is successfully produced when we take advantage of the alternation between the Lamarckian and Darwinian strategies.

The examples given concerning the mental models used in designing the new Honda vehicle are an application of this multi-stage process. As a matter of fact, the creation of prototypes is not purely incidental - as it is in a Darwinian strategy. However, the initial constraints are modest: they correspond to implicit models which generate very few constraints (remember the sphere-shaped model of the Honda City car?). Only after the design process, and thanks to a Lamarckian process, are the market-induced constraints applied by potential car buyers until the final design of the car is produced.

The multi-stage strategy takes into account the social constraints effecting innovation. Creativity alone is not enough; its products must be gradually filtered by the market, which constitutes a very powerful constraint. We could say that to innovate is the same as to recognize something in an event that no one else has seen or discovered before, but which many would have liked to. The concept of creativity manifests itself in product or process innovation only if its “social use” is recognized by the market.

The history of companies and firms is full of examples where a new category of products was “envisaged”. Almost every company manual contains some sort of reference, great or small, to the story (fable?) of the inventors of the Apple computer, who saw in the “personal computer” not a smaller or portable computer, but a new category of products. It was not just a matter of introducing new technologies, but the ability to recognize in something the potentiality for something else. For example, a poorly designed glue was turned into a successful product called the Post-it. Or the foam used strictly for shaving became the foundation for another cosmetic product. In this case the foam was no longer regarded as a shaving cream for men, but as a hair product for women (this is how the modeling foam Free-Style by L’Oreal was introduced to the market more than twenty years ago). Another example is that of Rocher chocolate candies, which recalls the creamy chocolate spread of Nutella, a widely successful product in Italy for over fifty years. As for taste and smell, Rocher candies are just like the Nutella spread except that they are presented in a different form. Therefore, as adults we can shamelessly enjoy an old pleasure that we may very likely have forgotten.

The cognitive constraints which prevent us from seeing things in an innovative way, and which get broken up in order to generate creativity, may originate from the traditions of a given, established sector. For example, for years American financial state bonds were sold together with dividend coupons (annual returns). Then one day a stockbroker working at Merril Lynch in Florida came up with the idea of selling the bonds without the dividend coupon. Thus, the zero-coupon bond was born, i.e., bonds without coupons. This financial product is very effective if someone wishes to postpone their return, say for the purpose of creating a university fund for a young niece or nephew. By buying zero-coupon bonds now, and at low cost, within fifteen years they will have matured into a considerable sum.

Peter Drucker, a well-known company consultant, once said, “Companies, ask yourselves this question: ‘what do our clients really want?’ Don’t be made prisoners by what you were used to offering them in the past, for one of your competitors just might ask himself the right questions!”.

A general scheme of creativity and innovation

The two types of processes, Lamarckian and Darwinian, form the paradigms on which we can formulate a general theory about innovation and creativity. To this purpose it is necessary
to link the processes with the different types of knowledge described and analyzed in previous chapters. What results is a general scheme combining the four types of knowledge (the four rows in table 1) and the two types of processes (the two columns in table 1).

Table 1. General scheme of creativity and innovation

<table>
<thead>
<tr>
<th></th>
<th>Lamarckian process</th>
<th>Darwinian process</th>
</tr>
</thead>
<tbody>
<tr>
<td>EW: representations in the external world</td>
<td>Insight</td>
<td>Trial and error</td>
</tr>
<tr>
<td>OI: methods for obtaining information</td>
<td>2-4-6: falsification</td>
<td>2-4-6: via quasi-random tests</td>
</tr>
<tr>
<td>OMO: relationship between the minds of others and our own</td>
<td>Beauty contest with insight</td>
<td>Beauty contest repeated</td>
</tr>
<tr>
<td>NCK: non-codifiable tacit knowledge within companies</td>
<td>Post-it</td>
<td>Zipper</td>
</tr>
</tbody>
</table>

All the various cases and examples analyzed thus far can be ascribed to the different cells portrayed in the general scheme above.

Solving problems belongs in the first row: to the left are placed the cases of insight, including those described by the Gestaltists; to the right are placed the procedures made via trial and error (e.g., finding the right key from a bundle or a street in an unfamiliar city).

In the second row from the top, we can place the strategies for obtaining information. This can be carried out in a critical manner, so as to arrive at the solution in an efficient manner, with immediate recognition of the constraints present in the situation. In this case we can resort to a strategy based on the falsification of hypotheses, as we saw in the “2-4-6” test. Vice-versa, we can proceed by quasi trial and error, in an attempt to find positive cases (unfortunately these may be infinite in number) for our hypothesis.

The third row from the top contains the two cells which correspond to all social problems requiring empathy. We have already examined the experimental version of the beauty contest. Here I mentioned scenarios which correspond only to the left column. To reproduce examples pertinent to the right hand column, we would need to repeat the game several times. Then, through trial and error, everyone would discover the answers made by the others and use this information to their advantage.

In the bottom row, the two cells contain all the cases which are founded on non-codifiable company knowledge. Actually, the complex examples we have analyzed thus far are a combination, or mesh, of multiple cells, according to the multi-stage structure, in that insight and trial-and-error processes are intermixed. Let’s take for example a typical case involving the contamination of the two structures, such as the invention of the plastic ski boot. We can say that the cell to the left in the last row is similar to the innovations produced by insight (such as the pull-tabs on beverages cans or the Post-it), whereas the cell to the right corresponds to the gradual and arduous processes of innovation (like that of the zipper or the car).

The crucial question here is whether this matrix is exhaustive or not. Can we use it to classify and analyze every process of creativity and innovation?
In my opinion it seems to be exhaustive in the case of knowledge, as well as in the case of processes, on the condition that we combine the two “archetypical” cognitive architectures in the multi-stage strategy. In such a case the concrete examples of creativity and innovation correspond to different combinations of the eight cells described in the general scheme. These, in conclusion, seem to be the paths to creativity.

**Can we learn to be creative?**

The complexity of the creative process that emerges from this scheme, allows us to reconsider, under a new light, the old-standing problem of educational theory in creativity. At the end of the previous chapter I mentioned the simplistic hope of promoting creativity by citing emblematic cases such as those studied by the Gestaltists, or those of company success stories. This hope is vain because, if creativity and innovation are the result of the combination of processes which we have outlined thus far, then each creative act cannot be repeated in its original essence. Only in retrospect, after placing the event or situation in one of the cells of our matrix, can we investigate and dissect the creative act. However, understanding the different cases of creativity and innovation is an indispensable condition if we wish to reproduce them. In this sense, the general theory explained here is not only descriptive but also pedagogic.

There are no definite recipes for creativity and innovation. However, it is possible to train oneself and try to be prepared for them. The training begins with an understanding of the cognitive obstacles, namely all that inhibits us in our search for new paths. A chapter of this book is dedicated to describing the main cognitive constraints. Training may also consist in understanding the different strategies which can be used and in their application to imaginary cases or “simulated” scenarios. After all, the pleasure in understanding the feats of a great detective or scientist lies precisely in understanding how these simulations, even if fictional, work. Something similar to the pleasure James Ackerman must have felt in figuring out the invention processes behind the construction of buildings, mentioned earlier in this book.

The first question we should ask ourselves when dealing with contexts which require creativity is which strategy would be best to adopt at this very moment. We should remember that the pedagogic problem is further complicated by the fact that we are not always aware that we are facing with a problem. In fact, we have already seen that the true and genuine cases of creativity and innovation consist in seeing a problem where no one, up until then, has before. In general it is important to hold a critical, curious, and even doubtful attitude towards what surrounds us. In order to be able to see a problem, or to make good use of an occasion, we should not take anything granted (and here it may be useful to know what the cognitive constraints to creativity are).

At this point, let’s suppose we are indeed aware that there exists a need for a new idea, mainly because we find ourselves in difficulty. Now we must decide if the problem is one which lies in front of us, or if it lies within us. If the latter case is true then the solution to the problem often consists in its dissolution. In other words, we must distinguish whether the difficulties reside in the world around us, or in our minds, or in the minds of others. If we deal with the latter of these three, then empathy, or social creativity, and so-called emotional intelligence are needed.

If we are faced with a truly authentic problem, and not a mental cramp that needs only be worked out, then finally things seem relatively more simple. Despite this, the fact remains that no one will ever be able to provide us with an algorithm for creativity or innovation. We can only proceed by way of analogy.
Useful questions to ask yourself: Have similar problems ever come up in the past? In which cell of our matrix can the new problem be placed? What is the best strategy to use? If in the past we resolved similar looking problems (but were they really similar?) by using a certain general strategy, how can we apply that strategy to this new case? If the problem is restricted or not well-defined, then it is more appropriate to proceed, right from the start, with vague and implicit mental models. Let’s allow the problem to settle for a while. In this way the mental models will become clear on their own. The problem is what guides us, as if we ourselves were not resolving it. This is the image that emerges, more or less, from those individuals in history who have had great ideas. An example of this can be seen in the interviews which the renowned Gestaltist psychologist Max Wertheimer conducted with the great scientist Albert Einstein. Such interviews revealed how certain problems remained embedded in Einstein’s mind until they were resolved, almost as if by themselves. So without becoming fixated, hasty, or anxious let’s consider this more thoroughly. In cases such as these, collaboration may be particularly advantageous especially if we also consult experts on the matter. Yet, at times, it is the inexperienced or the naïve person who most readily finds the key to the problem. They are often able to restructure the scenario by the introduction of a new perspective. As you can see, there are no recipes. However training ourselves can be very helpful.
Epilogue

The question of creativity reminds me in many aspects of the question of happiness. Those who are happy do not ask themselves if they are happy or not. Whereas those who do ask themselves this question, could come to a better understanding of what lies at the core of this question by proceeding “in negative”, rather than “in positive”. In other words, it is easier to explain what prevents us from being creative or happy than to explain what helps or allows us to be so. If we proceed by eliminating that which is not “happy or creative”, it allows us to set down and detail the most important questions. Having spoken of that which “X is not”, of human limits, of constraints, of errors, of dogmatic thought, of fixation and narrow-mindedness, I hope to have made that variegated and complex ground of creativity (where X resides), gradually clearer and more apparent. In fact I visualize the functioning of creativity as that of a kingdom, where the king appears free and limited by no one. And yet, as we have well seen, supporting actors are always discovered to be present. These actors do not only constrain the king, but also force him to continually foster a process of emphatic exchange with them, obeying rules that are not easily codifiable.

What I just attempted to express, can be explained much better by the excerpt taken from Norbert Elias’ admirable book, The Court Society, on the French King Louis XIV:

The position of King Louis XIV exemplifies very well the possible similarity of two phenomena. Such phenomena, considered in a purely philosophical sense and without reference to any concrete phenomena, may appear totally incompatible: the vastness of his decisional range – often understood as “individual freedom” – is the entity of his dependency on others […] The enormous opportunities for power he had at his command, thanks to his position, could have been preserved only by managing, with great care and calculation, the entire and composite balance of his reign/range of power, including both the more limited/restricted one, as well as the wider one. Classification and ceremony constituted the organizational instruments which he needed in order to maintain distance between all groups of people and the court society, which included himself, and thus also for maintaining the balance between the populace and the people in the center core of the kingdom’s elite.19


The source for the discourse on changeability of company knowledge, and on the market as a mechanism for discovery, is a monographic edition of “Industrial and Corporate Change”, vol. 9, n. 2, 2000 (cf. Also the classic works by G. Becker and G.J. Stigler published by Il Mulino).


Elaine Scarry, professor of aesthetics at Harvard University, has developed the theme of beauty as an inducer of repetition in the following two essays: *La sofferenza del corpo*, Bologna, Il Mulino, 1990 and *Sulla bellezza*, Milan, Il Saggiatore, 2001.

The works of Mary Miss are found in *Costruire luoghi*, edited by C. Zapatka, Motta Architettura, Milan, 1996. For an analysis of the analytical fragmentation in Cézanne, from the principle of simultaneity in analytical cubism, cf. pp. 18-25 and 117-126 in G. Dorfles and A. Vettese, *Arti Visive*, Bergamo, Atlas, 2000. This same text was an excellent source for talking about the problem of artistic creativity together with the documented essay by A. Vettese, *Capire l’arte contemporanea*, Turin, Allemandi, 2004, and also the article on


The story on the geckos can be found in Pnas, in a series of works dating from 2002 to 2005 (www.pnas.org), while the simulation of scientific creativity, including an intervention made by me, is found in the journal “International Studies in the Philosophy of Science” 1992, n. 1 of vol. 6.

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